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163rd Session (1950-51)

Vol. 163

Part 3

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1952

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PROCEEDINGS OF THE LINNEAN SOCIETY OF LONDON

Session 1950-51

Vol. 163

Part 3

PROCEEDINGS OF THE GENERAL MEETING ON 5 April 1951

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 8 March 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. A. E. Blake, K.L.B., Professor G. D. Hale Carpenter, M.B.E., Dr. G. S. Carter, Señor Guillermo Hernandez de Alba, Mr. A. A. Prestwich, Dr. C. G. G. J. van Steenis, and Professor F. E. Weiss, F.R.S.

The following signed the Obligation in the Roll and Charter Book and was admitted a Fellow :—Dr. Bernice Giduz Schubert.

In accordance with Chap. 10, Sect. 8 of the Bye-Laws, the following Fellows were elected, by show of hands, as Auditors of the Treasurer's Accounts for 1950-51 :—

Representing the Council : Dr. W. E. Swinton,
Dr. George Taylor.

Representing the Fellows : Mr. I. H. Burkill,
Professor F. W. Jané.

The proposed Alterations in the Bye-Laws, as printed in the report of the Meeting held on 22 February 1951, were balloted for and accepted.

Certificates of recommendation for election to Fellowship, in favour of the candidates named in the Minutes of the Meeting of 8 March 1951 were read for the second time, and for the first time in favour of Michael Robin Alexander Chance, B.Sc., Ph.D., Alan Philips Graham, M.A., Prof. James Eric Smith and Miss Eunice Sylvesta Lorraine Jones, M.Sc.

The PRESIDENT read a letter from Dr. THEODOR MORTENSEN, F.M.L.S., thanking the Society for the award of this year's Linnean Gold Medal.

Universitetets Zoologiske Museum,
København.
15 March 1951.

To the ASSISTANT SECRETARY OF THE LINNEAN SOCIETY OF LONDON.

Dear Sir,

Your letter of 9 March informing me that I have been nominated for the award of the Linnean Medal gave me a great, and most agreeable surprise. That the Council of the Linnean Society has found me worthy of this great and rare honour gives me a very deep pleasure and a feeling of the deepest gratitude. It is a matter

of deep regret to me that I shall be unable to attend the meeting on 24 May. I am suffering from a rather severe angina pectoris, which forbids me any more voyages. Fortunately my working capacity is not influenced thereby—if only I stay quietly at home. Otherwise it would have been glorious to see London once more and to attend the meeting of the Linnean Society to receive and personally express my deep gratitude for the great honour to be bestowed upon me.

Yours very sincerely,
TH. MORTENSEN.

The following communications were read and discussed :—

Prof. G. D. HALE CARPENTER, M.B.E. The butterfly genus *Euploea* in the South Pacific, from Papua to Australia and Tahiti: a biogeographical study (Discussed by Dr. Hugh Scott, F.R.S., Dr. G. S. Carter, Dr. C. F. A. Pantin, F.R.S., and Dr. A. J. Cain.; Prof. Hale Carpenter replied.)

Abstract,—

Euploeinae are a subfamily of Danaidae, with well marked characters. The males have elaborate scent-producing and distributing organs, often associated with alterations in the shape of the wing. The pattern is predominantly spotted, and its origin and peculiarities were discussed. The attractive blue gloss on many of the males of continental and Malaysian species has resulted in their being well known to travellers, and brought home as trophies, perhaps because being typically aposematic they are easily caught. They have a very persistent mousey odour.

Euploea is characteristic of the Indo-Australian region, but four isolated species are known from the Ethiopian region on the islands Bourbon, Mauritius and Rodriguez; they never reached Madagascar. India and New Guinea seem to have been the centres from which dispersal took place: in the N. Pacific they reached Formosa and the Loo-choo islands, Palau and Guam, but not Hawaii. In the south Pacific they reached Northern and Eastern Australia, and all the island groups from Papua east and south as far as Tahiti, but not the Marquesas. The late A. S. Corbet revised the taxonomy in 1943, forming eleven 'groups', of which four do not enter our area.

This study was based on detailed examination of 9,100 specimens recorded, and many others were ignored because of inadequate data.

The details of geographical distribution show that the islands in our area can be subdivided into eight major groups, of which some can be subdivided. These were discussed, special attention being paid to Rennell Island. A striking feature of the islands at the south-eastern end of the Solomons was the prevalence of white-bordered forms in apparent mimetic (Müllerian) associations.

Some data appear to support the theory, in connection with 'drifting continents', that New Guinea has intruded between the Moluccas and the Solomons.

Dr. S. M. MANTON, F.R.S. Habits and the evolution of the larger Arthropodan groups. (Discussed by Dr. C. F. A. Pantin, F.R.S., Prof. G. D. Hale Carpenter, M.B.E., Mr. R. B. Freeman, M.B.E., and Dr. A. J. Cain; Dr. Manton replied.) [To be printed in full in Journal, Zoology No. 284.]

Abstract,—

A study of the locomotory mechanisms of the Arthropoda shows that a differentiation of habits must have taken place in primitive animals living in the same environment. The persistence of such habits over long periods of time

has led to the evolution of morphological features which facilitate the execution of the selected gaits, and this has been a major factor resulting in the differentiation of many of the larger groups.

Some general features which control the number of leg bearing segments possessed by an arthropod were considered. An increase in leg length is advantageous for speed, but also introduces mechanical difficulties. The latter are eliminated by a reduction in leg number, and the hexapodous condition has been evolved independently many times.

PROCEEDINGS OF THE GENERAL MEETING ON 26 April 1951

Lieut.-Col. R. B. SEYMOUR SEWELL, C.I.E., F.R.S., F.L.S.,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 5 April 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. H. H. Bloomer, Mr. M. R. Henderson, Miss Elisabeth Inglis-Jones, Mr. Richard Morse, and Mr. S. Gordon Smith.

The following signed the Obligation in the Roll and Charter Book and was admitted a Fellow :—Dr. Kenneth Noel Grant MacLeay.

The Chairman reported the deaths of Christopher Albert Walter Sandeman, Fellow, and Thomas William Burton, Associate *honoris causa*.

The following candidates for Fellowship were balloted for and elected :—Sidney Fay Blake, A.M., Ph.D., Alexis Bogdan, John Leonard Cloudsley-Thompson, M.A., Ph.D., Joseph George Cockburn, M.Sc., Ph.D., Miss Winifred Mary Curtis, M.Sc., Ph.D., Miss Sylvia Mavis Dixon, B.Sc., Jan Bevington Gillett, M.A., Christopher Leighton Hare, M.Sc., Ph.D., Stanley John Hughes, M.Sc., Ronald William John Keay, M.A., B.Sc., Leonard Nixon Kidd, Edmund James King, M.A., Norman Robert Lee, B.Sc., Rev. Professor R. Lepour, S.J., Ph.L., L.D., Miss Winifred May Page, M.Sc., Ph.D., Reginald Arthur Peachey, Anthony Brian Lowsley Peake, M.A., M.R.C.S. (Eng.), L.R.C.P. (Lond.), Miss Frances Pitt, Peter Bernard Platts, Frederick John Reed, Robert Ross, M.A., Gilbert Westacott Reynolds, Robert Joseph Gay Savage, B.Sc., George Herbert Sewell, G. S. Verma, M.Sc., Ph.D., John Thornton Wildash, Mohammed Badi uz-Zaman Zaman, M.Sc.

A certificate of recommendation for election to Fellowship was read for the first time, in favour of Miss Lilian Haywood Eaton, B.Sc.

Certificates of recommendation for election as Foreign Members were read for the first time, in favour of Professor Bertil Hanström, Ph.D., of the Zoological Institute, Lund, Sweden, and Professor Lorenzo Raimundo Parodi, of the University of Buenos Aires.

The following communications were read and discussed :—

MR. W. E. HOLLOWS. Exhibit of tropical seeds, mostly Leguminosae, washed up on the shores of Devon and Cornwall. (Discussed by Mrs. Vera Higgins; Mr. Hollows replied.)

Dr. E. TREWAVAS and Dr. W. E. FROST opened a DISCUSSION ON BREEDING HABITS AS A FACTOR ISOLATING POPULATIONS OF FISHES. (Discussed by Mr. Burd and Dr. G. S. Carter.)

Abstracts,—

Dr. E. TREWAVAS : Even before the development of the mathematical theory of differentiation of isolated populations, it was accepted that any form of isolation that included the separation of breeding groups inevitably result in differentiation. The converse was assumed for example in Schmidt's work on the eel problem, one link in which was the following argument :—the characters of the populations of elvers entering all European rivers are shown to be identical ; therefore they must be parts of a single interbreeding population.

Many fishes breed in shoals without pairing. Of these Mayr (1942) postulates that the external stimulus for spawning must be narrowly specific, otherwise "sympatric species might spawn together, thus exposing themselves to the danger of considerable hybridization".

In a species like the herring, with a wide distribution, it may well be that it has been prevented from splitting into well-defined species because the spawning stimulus is not so narrowly specific. There are shoals of predominantly autumn-spawners and others predominantly of spring-spawners, but it does not appear to be proved that spring-spawners always breed spring-spawners.

Among fishes that pair we may have patterns of breeding behaviour as specific as those of birds. An interesting survey of such behaviour in Cichlidae has recently been published by Dr. and Mrs. Baerends (1950). This deals with the aspects of breeding behaviour that can be studied in aquaria. Related species have been studied in their natural environment by Miss R. H. Lowe, who, in a paper still in the press, has shown how Nyasa species almost indistinguishable in museum samples, show their distinctness in the field especially by their different breeding seasons and places, by different breeding dress of the males and by different duration of the period in which the young shelter in the parental mouth. This last habit involves mutual behaviour of parent and young.

These two techniques, the analysis of behaviour in aquaria and the study of behaviour in the field, are not easily applied to fishes, but if they can be combined they will lead to a much truer understanding of the differentiation of species than that obtained by morphological studies alone. In the Nyasa *Tilapias* the basic differences are ethological and especially connected with breeding and it is here that we must look for the cause of specific divergence, the morphological aspects of which may be only incidental.

Dr. W. E. FROST : Among salmonid fishes there is no proof that specific patterns of breeding behaviour keep related sympatric species apart, but there are several examples, principally among the Salvelinids and Coregonids, of related populations in a single lake that are isolated by the time or place of spawning, or by both. In Windermere the char, which have been considered a single sub-species, *Salvelinus willughbii* (Günther), breed at two distinct times, November–December and in February–March and at two distinct places, the Autumn (Nov.) spawners in shallow water (2 to 3 m.) the Spring (Feb.) in deep water (20 to 30 m.). There appear to be no morphological differences between the fish of the two populations, but the growth-rates are different after the third year. If, as seems possible from the evidence at present available, the time and place of spawning are hereditarily determined in each case, we have the beginning of a differentiation that has not yet expressed itself in morphology.

Similar differentiation in time and place of spawning characterizes the populations of char (*Salvelinus*) and whitefish (*Coregonus*) in certain lakes in Austria, Germany and Sweden. One such pair of sympatric forms is being made the subject of experiments in Sweden (Svårdson 1950). In their parent

lake they were distinguished by different spawning seasons, different growth-rates and maximum sizes and different body proportions and numbers of gill-rakers. Samples were transplanted to two lakes hitherto without fish, one form to each lake. Their growth-rates changed, and with them their proportions, but so far as the experiment has gone the breeding times seem to remain as before. If these breeding times continue to remain fixed and hereditary the populations must remain separate and Svårdson suggests that they would have to be regarded as species, however much their proportions might be moulded by the environment acting through the growth-rate. Further analysis is required, however, especially of the factors which decide the spawning season, whether internal or external. The work of Fabricius (1950) and others on Coregonids indicates that these factors are complex.

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 BAERENDS, G. P. and T. M. BAERENDS-VAN ROON. 1950. The ethology of Chichlid fishes. *Behaviour*, Suppl. 1, Leiden, 1-242.
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 FABRICIUS, E. 1950. Heterogeneous stimulus summation in the release of spawning activities in fish. *Ann. Rept. Inst. Freshwater Res., Drottningholm*, No. 31, 57-99.

PROCEEDINGS OF THE GENERAL MEETING ON 10 May 1951

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 26 April 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Mr. J. E. Dandy, Professor F. E. Weiss, F.R.S., and Mr. J. H. G. Peterken.

The following signed the Obligation in the Roll and Charter Book and were admitted Fellows:—Miss Sylvia Mavis Dixon, B.Sc., Mr. Norman Robert Lee, B.Sc., and Dr. Joseph George Cockburn.

Certificates of recommendation for election to Fellowship were read for the second time, in favour of Dr. M. R. A. Chance, B.Sc., Miss Lilian Haywood Eaton, B.Sc., Mr. A. P. Graham, M.A., Miss Eunice Sylvesta Lorraine Jones, M.Sc., and Professor James Eric Smith.

Certificates of recommendation for election as Foreign Members were read for the second time, in favour of Professor Bertil Hanström, Ph.D., and Professor Lorenzo Raimundo Parodi.

The PRESIDENT reported the death of Rear-Admiral Tufton P. H. Beamish, C.B., Fellow of the Society.

The following communications were read and discussed :—

Mr. J. T. ROBINSON exhibited casts and original specimens of the fossil primate *Paranthropus crassidens* found at Swartkrans, near Krugersdorp, S. Africa, by the late Dr. ROBERT BROOM, F.R.S. A discussion followed, in which the following took part,—Professor S. Zuckerman, C.B., F.R.S., Dr. L. H. Wells, Professor W. E. Le Gros Clark, F.R.S., and Dr. A. Tindell Hopwood.

The following papers were read in title,—

'A new Glycyphagid Mite—*Carpoglyphus munroi*'. By A. M. HUGHES, B.Sc., D.I.C., F.L.S. [Printed in *Journ., Zool.*, No. 284.]

'Studies in the Arabian Orthoptera.—III. New genera, species and subspecies collected by the Anti-Locust Missions'. By B. P. UVAROV, C.M.G., D.Sc., F.R.S., F.L.S. [Printed in *Journ., Zool.*, No. 284.]

'A contribution to the floral morphology and embryology of *Dendrophthoe falcata* (Linn. f.) Ettingshausen'. By BAHADUR SINGH. [Printed in *Journ., Bot.*, No. 355.]

'Embryological studies on *Spiranthes australis* Lindl.'. By P. MAHESHWARI and S. NARAYANASWAMI. [Printed in *Journ., Bot.*, No. 355.]

'New and rare British Spiders'. By A. F. MILLIDGE and G. H. LOCKET.

THE AUSTRALOPITHECINES AND THEIR EVOLUTIONARY SIGNIFICANCE

By J. T. ROBINSON
(Transvaal Museum).

The Australopithecinae are too well known by now for it to be necessary to give an historical introduction to this discussion. It would, perhaps, be more pertinent to begin with a brief sketch of the geology of the finds.

Fairly extensive exposures of dolomitic limestone, of Precambrian age, occur in the Transvaal and the neighbouring parts of Bechuanaland. During the Palaeozoic and Mesozoic these were overlaid by Karroo sediments which were stripped off during Tertiary times. This erosion was probably completed during the Miocene with the result that further erosion caused fissuration and cavern formation in the dolomite beds. Subsequently a wet phase resulted in the deposition of a thick band of travertine of a high degree of purity in some caverns where conditions were suitable. This was followed by at least one period, possibly several, of drier climatic conditions during which Kalahari-type sand accumulated in caves and fissures which were open to the surface. Animal remains which found their way into these caves were covered up by the sand, thus increasing the chance of preservation. These conditions may have persisted for thousands or even hundreds of thousands of years. As new caverns were continually being opened it is readily apparent that a series of samples of the local fauna would have been preserved. It also follows that the remains in adjacent caves may easily represent faunas separated by ten or a hundred thousand years. This dry period, or periods, was apparently followed by a moister period during which travertine was again deposited. This time it did not form in a thick band but was deposited between the grains of sand and other debris on the cave floor. In this way a hard, well consolidated bone-bearing breccia came into existence. Further erosion has reduced or even entirely removed the roofs of these caves so that many of the deposits occur as weathered patches flush with the present land surface.

So far no accurate geological method has been devised for dating these deposits. The fauna appears to be of Villafranchian type and we may thus

provisionally fix the era of the known Australopithecines as falling on or about the Plio-pleistocene junction. This dating assumes the Pleistocene period to have commenced, in round figures, one million years ago, with the Villafranchian representing the time from the beginning of the Pleistocene to the onset of the first glaciation.

Specimens of the Ape-men have been obtained from the following five sites in South Africa, in the order of discovery: Taungs, in Bechuanaland; Sterkfontein and Kromdraai, two miles apart near Krugersdorp and roughly twenty miles west of Johannesburg; Makapansgat, near Potgietersrust in central Transvaal and Swartkrans, a mile from Sterkfontein.

In general external appearance the known Australopithecine skulls resemble those of the great apes having a flat face and small braincase. *Plesianthropus* is fairly prognathous, while *Paranthropus crassidens* has a broad, flat and vertical face unlike that of any known living or fossil pongid. Regarding endocranial capacity we are not on secure ground. The undistorted and virtually complete *Plesianthropus* skull has a capacity of 480 cm³. The Taungs child, with only the first permanent molar erupted, has half the endocranial cast preserved and a reliable estimate of 500 cm³. can be made. In a juvenile specimen from Swartkrans, which is of comparable age judged by the stage of eruption of the permanent dentition, the braincase length is 20 to 25 mm. greater than that of the Taungs child and the breadth is proportionately greater. From this and the adult crania in our possession it seems that the general order of brain size of the adult *P. crassidens* is comparable with that of the smaller specimens of *Pithecanthropus*—roughly 800 cm³.* But it is not clear what significance this might have. If correct it would mean that this form has an endocranial volume appreciably greater than any so far recorded for the great apes but it certainly does not allow us to estimate the intelligence of *P. crassidens*.

The foramen magnum is situated well forward in the base of the skull in a position anterior to that usual in adult pongids. In the latter group the foramen magnum is situated well forward in infants but by the time growth is complete it has adopted a position more posteriad and is directed backward and downward. In Australopithecines this backward migration does not occur; as in the hominids the infant and adult positions are similar. In all cases where the mastoid region is intact, in infant or adult skulls, a small, pyramidal type of mastoid process occurs which has a clearly defined digastric groove associated with it. According to Schultz true hominid mastoid processes do not occur in the Pongidae. The young have no mastoid protuberances but some elderly individuals do have processes which are, however, unlike those typical of hominids.

The nature of the glenoid fossa is of considerable interest. In the Pongidae this is wide and shallow, having no articular eminence but a post-glenoid process occurs which prevents the mandibular condyle from articulating with the tympanic bone. In hominids the fossa is deep and narrow with an articular eminence and a small postglenoid process closely applied to the tympanic bone, which forms the posterior wall of the fossa. Among the Australopithecines, skull V from Sterkfontein has a somewhat pongid type of glenoid fossa while all other known specimens, including two others from Sterkfontein, have the hominid type.

Among the important finds have been three innominate bones belonging to three different genera, as the classification now stands. All show similar characteristics and can easily be distinguished from those of the Pongidae but less easily, though none the less certainly, from those of the Hominidae. In general appearance the australopithecine innominate is of the hominid type

* Pith. II estimated at 755 c.c. by Von Koenigswald (*in litt.* Le Gros Clark).

with a low but widely expanded iliac blade, a well developed anterior inferior spine and with the acetabulum so situated that an axis passing through its centre is directed at a considerable angle to the iliac blade. There is also a well developed anterior superior iliac spine—which is not a hominid feature. The ischium has the distance between the acetabular rim and the distal area of muscular attachment relatively great; in which feature it approaches the pongid condition. Except for this point the innominate does not resemble that of the great apes closely. The characters of the australopithecine innominate are those which are associated with a primate habitually employing an erect, bipedal gait. The position of the foramen magnum is in agreement with such a conclusion. The nature of the ischium is perhaps an indication that the bone had not yet been completely adapted to a fully erect gait.

Let us now consider some features relating to the dentition. If we reduce the various jaw movements to components in vertical and horizontal planes we see that in the great apes mandibular movements are confined almost entirely to a vertical plane whereas in Hominidae a considerable horizontal component is also present. The restricted movement in pongids is due to the usual presence of canines which are large enough to prevent much lateral jaw movement. In elderly individuals, more especially females, this may not apply. However, this situation results in different types of tooth wear in Pongidae and Hominidae. In the former, canine wear is greater on parts of the sides of the tooth than on the tip, and the post-canine teeth wear more rapidly on the lingual half of the crown in the upper jaw and on the buccal half of the crown in the lower jaw. In hominids the canine wears most rapidly on the tip and the post-canine teeth wear down evenly. *P. crassidens* dentition is better known than that of other known Australopithecines. In this form the canines do not project beyond the rest of the tooth row and all the teeth wear down evenly in the hominid fashion. Incisors and canines are small, markedly resembling those of hominids and could not possibly be confused with those of pongids.

The first lower premolar is an interesting tooth. In the Australopithecines this tooth is, in every known case, a strongly bicuspid tooth with two roots which are entirely fused down one side and incompletely so on the other. In hominids this tooth is always bicuspid, though in many cases the lingual cusp is appreciably smaller than the buccal one. There is usually a single root though traces of incomplete fusion on the mesial face are not uncommon—the so-called Tomes' abnormal root. Occasionally two roots are present. In the pongids this tooth is unicuspid with a low talonid developed from the cingulum. Two roots, unfused, are usual.

The second lower premolar shows a less striking difference in the two groups. In the pongids a pair of high and closely connected cusps occur; the talonid region is better developed than it is in the first lower premolar and lies at a lower level than the anterior cusps. In man and the Australopithecines the anterior pair of cusps are not so closely connected and lie on the same level as the talonid.

Regarding the upper premolars it is worth noting that in the pongids three roots are usual, in the Australopithecines two roots occur and in hominids usually either two or one, though occasionally three are present.

In pongids the first lower molar almost invariably has five cusps and where an additional cusp occurs it normally is situated between the metaconid and entoconid. It seems that a true tuberculum sextum either never occurs or is excessively rare. Gregory and Hellman have stated that this cusp is unknown in fossil and recent pongids. Hominids, on the other hand, do have this cusp in a small proportion of individuals. In *Paranthropus crassidens* ten teeth are sufficiently unworn to show the cusps and in nine a tuberculum sextum is present. In the tenth a rudiment is present but is perhaps too small to be

considered a true cusp. Most of the relatively few first lower molars of the other species of Australopithecines also have this cusp. This seems to be a significant feature; perhaps the Australopithecines have been the source from which hominids have inherited this cusp.

Schultz has shown that in the eruption of the pongid permanent dentition the second molar erupts before the majority of the milk teeth are replaced—usually only the deciduous incisors have been replaced at this stage. In hominids the sequence is different; the entire deciduous dentition being shed before the second molar becomes functional. Usually the first permanent molar erupts before the central permanent incisor but occasionally the latter erupts first. This has never been observed in any pongid where the permanent first molar is the first permanent tooth to appear. In *Paranthropus crassidens* one mandible shows the central incisors erupting before the first molars, another shows the reverse order, and an upper and a lower jaw show that the last deciduous tooth is shed at about the time the second molar becomes functional.

Not only is the time of the shedding of the deciduous dentition important but also the morphology of the individual teeth which differ considerably in the pongids and the hominids. The most obvious of the differences is the nature of the first lower molar. In pongids this tooth is semi-sectorial with a single, sometimes partially divided, central cusp and a low talonid with undifferentiated margin—that is, no true cusps occur on the talonid. In both hominids and the Australopithecines the tooth is relatively large and highly molarized, possessing the usual five cusps.

Before proceeding to an attempted assessment of the significance of the facts set forth above I wish to draw attention to a small group of specimens which were recovered from the same breccia mass that yielded the specimens of *P. crassidens*. These consist of a mandible, an isolated first lower premolar, probably from the mandible and the proximal portion of a radius which the late Dr. Broom and I attributed to a new type of early hominid, *Telanthropus*. These occurred in an area of darker breccia on the edge of the main mass, which fact suggested caution in assuming them to be of the same age as the *P. crassidens* material. With the help of Dr. K. P. Oakley and the Department of the Government Chemist in London, analysis of the fluorine content of *Telanthropus* and *P. crassidens* specimens has failed to demonstrate any difference in age.

It has been suggested that *Telanthropus* is, in fact, only an aberrant specimen of *P. crassidens*. For reasons which have been set forth more fully elsewhere and can only be touched upon here, such an explanation seems most unlikely. The general morphology and size of the body and ascending ramus of the mandible, the teeth and radius, point clearly to the fact that *Telanthropus* is a different creature. The teeth are considerably smaller than those of *P. crassidens* but agree well with those of early hominids. In the case of the first molar elementary statistical analysis shows that the difference in size between the *Telanthropus* specimen and the mean for 14 *P. crassidens* teeth is very highly significant.

In attempting the difficult task of assigning the Australopithecines to their correct evolutionary category it is inevitable that one's interpretation of primate evolution will influence the decision made. Any such interpretation must be largely concerned with teeth as they are often all we know of fossil forms.

The pongids are fairly well represented, by teeth at least, from the Oligocene to the present and one cannot fail to observe certain specializations that occur in all known fossil and living pongids. Some of these have already been mentioned, e.g. the semisectorial first lower premolar and robust canines. From *Propliopithecus* onward, these specializations have become more firmly established along with a tendency to elaboration of bony material in the skull; the production of heavy supra-orbital tori, crests, heavy muzzles and related

features. From the little evidence available, a concomitant specialization in limb structure has occurred. The modern pongids are highly specialized animals, the results of the type of specializing evolution which de Beer has called gerontomorphic and which results in a very low evolutionary potential.

Available material relating to hominid evolution does not go back nearly so far, but if we bear in mind the specializations referred to which so uniformly characterize the pongids some highly suggestive facts emerge. From this point of view *Proconsul* is already established in the pongid evolutionary stream; so also is *Propliopithecus*. Where these pongid specializations have become established we must assume the hominid and pongid evolutionary streams to be already separate. Hominids are relatively generalized and show paedomorphic or neotenic tendencies, i.e. the retention of infantile characters in later and later phases of ontogeny as phylogenesis progresses. Such a trend tends to maintain a high evolutionary potential. Hominids share a surprising number of characters with old world monkeys which are not possessed by pongids. It is generally believed at present that a late Eocene or early Oligocene radiation resulted in three streams: platyrrhine, catarrhine and anthropoid—the last group later giving rise to the hominid stream. However the considerations here dealt with suggest as more likely that at least *four* separate streams emerged from the welter of Eocene prosimians and, by the upper Oligocene, where pongids are identifiable, that the hominid stream was already separate.

In such a scheme there can be no doubt where the Australopithecines are to be placed—they belong in the hominid stream. The characters marking the pongid stream exclude them and they clearly have much in common with the hominids.

The australopithecine relationships within the hominid stream are less easy to determine. It seems improbable that those known at present could be human ancestors. However it is not unlikely that the known forms represent survivals of a once widely spread and vigorously evolving australopithecine family in Miocene and Pliocene times. If and when a prehuman ancestor of man is found it will doubtless fit most easily into this family. *Telanthropus* seems to represent at least one case where a proto-hominid Australopithecine crossed the rubicon and became a hominid. It is possible that this event happened more than once and in different places: we have no means of knowing at present, but patient and painstaking exploration in the rich deposits of Africa and the East may well throw floods of light upon this fascinating problem.

Discussion, —

Professor S. ZUCKERMAN: In contributing to this discussion, and in commenting on Mr. Robinson's observations, I shall try to differentiate as far as possible between questions of fact and matters of interpretation. In the first instance it is useful to emphasize that in general appearance and proportions the specimens of *Paranthropus* before us are not human but overwhelmingly simian. The more this fact is overlooked when stressing 'detailed' features which may differ from the corresponding ones in existing apes, the more likely we are to go astray in our assessment of the fossils. When considering differences, the question that needs to be asked is whether they are more marked than those that occur between existing and fossil types of great ape, and if so, how much more significant they are from the point of view of human phylogeny.

My own observations do not agree with those of Mr. Robinson about certain features of the simian skull. For example, he claims that a mastoid process of the type found in some australopithecine skulls is a hominid character, and he implies that a mastoid process is an exceptional occurrence in the African great apes. In point of fact, a freely-projecting mastoid process is more the rule than the exception in these animals, while the process as it occurs in

the *Paranthropus* specimens can readily be matched both in the gorilla and chimpanzee, and differs from the type usually found in Man. Mr. Robinson also suggests that the canines of the great apes cannot be worn down from the tip, and he claims that in these animals the movements of mastication are practically restricted to the vertical plane, there being little or no horizontal component. Again, my observations do not accord with this view. While wear occurs on the antero- and postero-medial aspects, it also occurs from the tip of the canines, which can eventually become so worn that their upper flat surfaces are in line with the incisors. Whether this is due to lateral movements of the jaws in mastication I do not know, but such movement does take place. My own studies also fail to bear out Mr. Robinson's statements about the order of eruption of the teeth in the Great Apes. In my experience, which was corroborated by Schultz, the permanent incisors as a rule erupt before the second molars.

One of the more important points made by Mr. Robinson concerns the forward position of the foramen magnum in the australopithecine skull, and its presumed failure to 'migrate' backwards during growth, as in the Great Apes. Professor Le Gros Clark has also drawn attention to this feature and has expressed it in terms of a 'condylar position index'. When 'taken in combination', the value of this index in the skull of *Plesianthropus* 5, that of a 'nuchal area height index' (which gives a measure of 'the relative height to which the nuchal area extends up on the back of the skull'), and of a 'supra-orbital height index' (which Professor Le Gros Clark uses to define 'the position of the brain-case relative to the upper part of the face'), 'appear definitely to place the australopithecine skull outside the limits of variation of the large anthropoid apes and to indicate a rather remarkable approximation to the hominid skull'.

Mr. Ashton and I have studied these indices in a wide variety and large number of Primate skulls, and can confirm Professor Le Gros Clark's finding that the values of the supra-orbital height and nuchal-area height indices of *Plesianthropus* 5 correspond to the human figures. On the other hand, we find that the 'condylar position' index in this fossil skull does not diverge in a statistically significant manner from that of the gorilla, and that it differs from Man and the other Primates which we studied. Professor Le Gros Clark relates the three indices to a common factor—the poise of the head in relation to the vertebral column. Our own observations do not suggest that the three indices are correlated in the way implied by Professor Le Gros Clark, and in so far as the condylar position index is a measure of the balance of the entire skull on the occipital condyles in relation to the vertebral column, they also suggest that if *Plesianthropus* 5 walked upright, its skull was not balanced like the human skull.

The fact that two of the *Paranthropus* specimens demonstrated by Mr. Robinson have pronounced sagittal crests bears on this conclusion. During the course of eruption of the permanent teeth in the living great apes, and the concomitant growth of the jaws, the temporal muscles extend upwards and backwards over the cranial vault to meet the upwardly-extending nuchal musculature (a process that is related to the relatively greater weight of the anterior part of the skull), and in this way the nuchal (occipital) crest is formed. As a general rule, the nuchal crest appears before the upwardly-extending temporal lines meet in the mid-line to form a sagittal crest. At the same time, and presumably because the face grows relatively more than the back of the skull, the position of the occipital condyles 'migrates' backwards.

I have examined many mammalian skulls, including ape and monkey, without encountering any specimen in which a sagittal crest is not associated with a nuchal crest. Mr. R. Savage has examined the question systematically, and has studied all the primate skulls in the British Museum; he has also made

a careful examination of Insectivora, Cheiroptera and Dermoptera, as well as a survey of Carnivora and Marsupialia. He, too, finds that the development of a sagittal crest is almost invariably associated with a nuchal crest. The sagittal crest usually begins to form posteriorly where the temporal lines come together in the region of theinion. Occasionally, e.g. Cheiroptera, fusion of the temporal lines begins anteriorly. If one of the two crests is missing, it is almost invariably the sagittal crest that is lacking. The only two cases in which Mr. Savage has observed a well-developed sagittal crest and a poorly-developed nuchal crest are (i) a specimen of *Nycticebus* and (ii) some skulls of *Nycterus*, the hollow-faced bat. Neither I nor Mr. Savage have ever observed this condition in a monkey or ape. Moreover, it should be observed that nuchal ridges are not uncommon in primitive human skulls, whereas a sagittal crest of the kind seen in *Paranthropus* and the gorilla is unknown.

Paranthropus crassidens obviously possessed a powerful jaw musculature. This is indicated not only by its powerful jaws but also by the presence of a sagittal crest, and by the depth of the temporal and infra-temporal fossae. Unfortunately, neither of the skulls before us is complete, and the nuchal area is lacking in both. But unless *Paranthropus* provides a single exception to what seems to be a general feature of the architectural dynamics of the Primate skull, our observations about the co-existence of sagittal and nuchal crests in Primates seem to indicate clearly that *Paranthropus crassidens* had a strong nuchal musculature of the kind seen in extant great apes, and that it would have had nuchal crests. As its skull was moulded during growth, the occipital condyles would almost certainly have 'migrated' backwards, as they do in existing great apes, and as the 'condylar position' index of *Plesianthropus* in fact indicates.

My own view is, therefore, that the evidence before us implies that *Paranthropus crassidens* held its head in the way one of the living great apes does, and not in the way we do—whatever views the form of the innominate bones before us may suggest about the orientation of its inferior extremities relative to its vertebral column.

It may be necessary to point out that most of the specimens of the Australopithecinae that have been described so far do not possess a sagittal crest. The living great apes are no different. Crests do not occur in young animals. The adult male gorilla almost always has a sagittal crest, but this is most unusual in the female, which usually possesses only a nuchal crest or ridge. The same applies to the orang-outang. A sagittal crest is a very rare phenomenon in the chimpanzee, and to the best of my knowledge it never occurs in the female.

This brings me to the question of interpretation. Mr. Robinson suggests that the position we take about the phyletic significance of the Australopithecinae is necessarily dependent on the general view one has about primate and human evolution. This seems to me to open the way to preconceived conclusions. My view is that one can only interpret the fossils in the light of the morphological facts themselves—and these are by no means as yet clear. Once the facts have been agreed, the next step is to assess the degree of resemblance of the fossils to the great apes, living and extinct, on the one hand, and to man, living and extinct, on the other. In certain features of the skull of *Paranthropus* (for example, the reduction of the canines and the concomitant alteration in the lower first premolar) we are dealing with what seems to be a significant difference between the fossils and living apes. The question we have to ask is whether this difference, and any like ones that may be defined, sufficiently counterbalance the overwhelmingly simian nature of most features of the skull to justify the classification of the Australopithecinae in the Hominidae as opposed to the Pongidae.

In conclusion I wish to thank Mr. Robinson most cordially for the opportunity of examining his specimens. While disagreeing on certain questions, I am at one with him in the desire to see the Australopithecine fossils properly assessed. They add a great deal to our knowledge of the fossil history of the Primates, and we are all deeply in debt to Mr. Robinson's chief, the late Dr. Broom, for having done so much to bring them to light. We can all hope that good fortune will continue to attend the explorations for which Mr. Robinson is now responsible.

Professor W. E. LE GROS CLARK said: there is a general consensus of opinion that the hominid sequence of evolution diverged from the anthropoid ape (or pongid) sequence as far back as Miocene times (and perhaps even earlier). But the palaeontological evidence at present available indicates that the expansion of the brain and the reduction in the size of the jaws and teeth characteristic of *Homo* did not become manifest till the beginning of the Pleistocene. Consequently there must have been a very long period in the evolution of the hominid sequence (i.e. the Hominidae) during which the brain-case, jaws and teeth retained proportions similar to those still shown by the anthropoid apes to-day. It is of the utmost importance to recognize this in discussing the relationships of the Australopithecinae. It has been suggested that the latter are representatives of what may be termed the 'pre-human phase' of hominid evolution (perhaps late survivors of a collateral branch that persisted in South Africa); if this is so, the obviously simian proportions of the brain-case, jaws and teeth are not immediately relevant to the discussion. These simian proportions have, of course, always been recognized by Dart and Broom and others. But the interesting point is that they are combined with morphological features hitherto only recorded in the Hominidae and not found in any of the Pongidae, recent or extinct. Such hominid features are now generally recognized. They include the pattern of the dental arcade, the spatulate form, relative size and mode of wear of the canines, the consistent absence of a diastema, the consistently non-sectorial bicuspid character of the first lower premolar, numerous details of the milk dentition (confirmed by a detailed statistical analysis), and the sequence of eruption of the permanent teeth. All these constitute a total morphological pattern consistently found in the Australopithecinae (of which many specimens are now available) and not demonstrated to occur in any group of anthropoid apes. The skull (in spite of its general ape-like proportions) deviates from all the anthropoid apes in the *combination* of the condylar position index with the supra-orbital height index and nuchal area height index, the consistently forward position of the condyles in relation to the auditory aperture, the details of the construction of the mandibular fossa and auditory region, the relative height of the temporal squama, the contour of the palate, the remarkably small area for the nuchal musculature (even in the Makapan occiput which showed that the temporal ridges must practically have reached the mid-line of the skull further forwards—with perhaps the formation of a median crest) and so forth. The limb-bones and the pelvis (of which there are now three specimens) demonstrate a similar combination of hominid and primitive characters. The pelvis, in particular, confirms the inferences which have been made on the basis of other parts of the skeleton regarding an upright posture approximating to that characteristic of man. The existence of hominid characters in the Australopithecinae is no longer in doubt. The difficulty arises in their interpretation. But they are, morphologically, clearly in conformity with the suggestion that these fossil creatures may be representative of the pre-human phase of the evolutionary sequence of the Hominidae. It does not necessarily follow, of course, that they were *directly* ancestral to *Homo sapiens*, or even to primitive forms such as *Pithecanthropus* (though this may have been the case). They may represent

a collateral branch of the hominid sequence, derived from an earlier ancestral group which gave rise to modern man. In any case, so far as the facts are at present available, the interpretation which seems best to fit these facts is that taxonomically they are to be assigned to the Hominidae rather than the Pongidae. Attention is called to the great care which needs to be exercised in the application of statistical methods to the study of these fossil forms, and particularly to the danger of drawing far-reaching conclusions from too limited statistical data.

Dr. A. TINDELL HOPWOOD, in winding up the discussion, suggested that the Australopithecinae might be placed in a 'suspense account' until more was known about their anatomy. In the meantime it would be advisable to forget the controversial aspects and to treat the fossils in exactly the same way as one would treat any other mammalian remains. If that were done, there could be no doubt that the specimens on the table were far too highly specialized to represent possible human ancestors; one need only mention the possession of a sagittal crest on the brain-case, the much enlarged teeth, and the very marked pachyostosis of the mandibular ramus.

The mandibular ramus was almost identical with a fragment found in Java by Prof. von Koenigswald. It suggested that the australopithecines might have been an Asiatic element in the African fauna—there is abundant evidence of faunal interchange at the appropriate times; alternatively, the specimen found in Java might represent an African element in the Asiatic fauna. If he favoured the former hypothesis rather than the latter, it was because the megacerotine deer, the only other terrestrial mammals with a corresponding degree of pachyostosis of the corpus mandibulae appear to be of Asiatic origin.

PROCEEDINGS OF THE ANNIVERSARY MEETING 24 May 1951

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 10 May 1951, having been circulated, were taken as read, and confirmed.

The PRESIDENT welcomed the presence at the Meeting of His Excellency Herr Gunnar Hägglöf, Swedish Ambassador, and Count E. Knuth, Counsellor at the Danish Embassy.

The PRESIDENT stated that HIS MAJESTY KING GUSTAF VI ADOLF OF SWEDEN had expressed his wish to become an Honorary Member of The Linnean Society of London.

The Linnean Society of London
Burlington House,
Piccadilly,
London, W.1.
2/4/51.

Your Excellency,

The Council of The Linnean Society of London are desirous of proposing the election of H.M. the King of Sweden and of the Goths and Wends as an Honorary Member in succession to their late Majesties Oscar II and Gustav V at our Anniversary Meeting on May 24th next, the day appointed by our Bye-Laws for such election,

May I, therefore, ask your Excellency to be so good as to ascertain whether His Majesty would be willing to accept this token of respectful regard and to extend to the Society that honour which we were privileged to enjoy from his Royal Predecessors.

I have the honour to be,
Your Excellency's most obedient Servant,
F. E. FRITSCH,
President.

His Excellency,
H:r Gunnar Hägglöf,
Royal Swedish Embassy,
29, Portland Place,
London, W.1.

Swedish Embassy in London,
29, Portland Place, W.1.
30th April, 1951.

Sir,

Acting upon instructions received I beg to inform you, with reference to your letter of April 3rd, that His Majesty King Gustaf VI Adolf has graciously consented to accept the Honorary Membership of the Linnean Society of London.

I have the honour to be,
Sir,
Your obedient Servant,
S. UNGER,
Chargé d'Affaires a.i.

F. E. Fritsch, Esq., F.R.S.,
President,
The Linnean Society of London,
Burlington, House,
Piccadilly, W.1.

His Majesty was formally elected with acclamation, all present rising in their places.

His Excellency The Swedish Ambassador then conveyed to the Fellows His Majesty's warm appreciation and pleasure at becoming an Honorary Member of the Society, and His Majesty's regret at not being present at the Meeting.

" Mr. President,

His Majesty King Gustaf Adolf has instructed me to express his warm appreciation and thanks for having been called to become an Honorary Member of this most illustrious and ancient Society. His Majesty has asked me to explain to you how much he regrets not being able to attend this Meeting in person.

I believe that we Swedes are particularly sensitive to this generous act, which we would like also to consider as an honour bestowed on our country, because we are so well aware of the deep impressions Linnaeus brought home from his visit to England during the early years of his life, impressions which were to make an impact on his whole outlook as a man and a scientist. Nor are we likely to forget that the first body of men to organize themselves for the purpose of studying and carrying on his work were the founders of your Society. This fact is only further

brought home to us whenever our own scientists come to London for a personal contact with you, be it for the purpose of studying the current problems of Botany or some of your rich material on that strangely fascinating personality that was Linnaeus himself.

I think few people can have a deeper understanding of these conditions than His Majesty himself, who, as you may well know, is not only a most keen and interested gardener but also has devoted part of his rare leisure to the serious study of your science. In concluding may I extend to you, Mr. President, His Majesty's best wishes for the future of this Society, a wish in which I am sure all his subjects would like to have a part."

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Dr. John Leonard Cloudsley-Thompson, M.A., Dr. Winifred May Page, M.Sc., Mr. Leonard Nixon Kidd, Mr. Edmund James King, M.A., Mr. Robert Ross, M.A., Dr. G. S. Verma, M.Sc., Mr. John Thornton Wildash and Mr. Mohammed Badi uz-Zaman, M.Sc.

Candidates for membership were balloted for and elected :—

Fellowship.—Maurice Robin Alexander Chance, B.Sc., Ph.D., Miss Lilian Haywood Eaton, B.Sc., Alan Philps Graham, M.A., Miss Eunice Sylvesta Lorraine Jones, M.Sc. and Professor James Eric Smith.

Foreign Members.—Professor Dr. Lorenzo Raimundo Parodi and Professor Bertil Hanström, Ph.D.

The Bye-Laws regulating the Election of Council and Officers having been read by the Assistant Secretary, the PRESIDENT declared the Ballot for new Members of Council to be open, and voting began. The PRESIDENT thereafter appointed Mr. H. R. Hewer, Mr. R. H. Jeffers and Mr. R. Ross, as Scrutineers of the Ballot.

The Ballot was closed at the due time, and the result declared to the Meeting.—NEW MEMBERS OF COUNCIL.—Mrs. F. L. Balfour-Browne, Mr. Alan Fisk, Mr. H. R. Hewer, Dr. B. M. Hobby, Professor F. W. Jane and Mr. Patrick M. Synge.

(The retiring Councillors were Professor A. J. E. Cave, Professor G. H. Hale Carpenter, M.B.E., Mrs. Vera Higgins, Mr. E. W. Mason and Dr. W. E. Swinton ; one Member resigned : Dr. W. R. Philipson.)

The PRESIDENT declared the Ballot for Officers to be open and voting began. The Ballot was closed at the due time, and the result declared to the Meeting.—OFFICERS.—*President* : Professor F. E. FRITSCH, F.R.S. ; *Treasurer* : Colonel F. C. STERN, O.B.E., M.C. ; *Zoological Secretary* : Dr. A. TINDELL HOPWOOD ; *Botanical Secretary* : Dr. GEORGE TAYLOR.

In handing the Linnean Gold Medal to Count E. Knuth for transmission to Dr. THEODOR MORTENSEN, F.M.L.S., the PRESIDENT spoke as follows :—

The LINNEAN GOLD MEDAL is awarded to Dr. Ole Theodor Jensen Mortensen. In making this award we honour a distinguished zoologist who was elected a Foreign Member of the Society as long ago as 1929. A frequent visitor to this country, either for purposes of study at the British Museum and the Plymouth Laboratory or to attend meetings of the British Association, many Fellows of the Society will know him personally and will welcome this tribute to his great distinction,

Dr. Mortensen's scientific career started in 1895 with his appointment to a post at the Danish Biological Station, but a year later he joined the staff of the Zoological Museum of Copenhagen where he subsequently became Director of the Department of Invertebrata and was able to devote most of his life to most fruitful researches. It was at the beginning of this century, while dealing with the Echinoids collected by the Danish 'Ingolf' Expedition that Mortensen recognized the highly unsatisfactory state of knowledge relating to this group, and this decided him to make their study his principal life-work. At an early stage in his researches he realized that the microscopic characters of the various appendages, which up to then had been almost ignored, were just as important as those of the test itself, and this led him to put forward an entirely new classification of the Echinoids. Material collected during his own travels to Siam (1900) and the West Indies (1906), as well as the investigation of that collected by the German and Swedish Antarctic Expeditions, proved the soundness of this new classification, but also suggested the desirability of studying further living material and especially the developmental stages of these organisms. This Mortensen accomplished by extensive travels at various times. From 1914 to 1916 he investigated many areas of the Pacific from Japan to Australasia, in 1929 he visited South Africa, Mauritius and St. Helena, and later paid two visits to the Marine Laboratory at Ghardaqa in the Red Sea.

Among the many memoirs in which the results of these investigations are presented, special mention may be made of that on the development of Echinoderms published in 1921, in which it is shown that the larval stages have an important bearing on, and help to confirm Mortensen's earlier views on, the classification of these organisms. The wealth of material obtained in the numerous regions he visited led him in the early twenties to decide to prepare a comprehensive monograph of the world's Echinodermata, including both the living species and the known fossil forms. The first volume of this monumental work, which was financed by the Carlsberg Foundation and dealt with the Cidarids, was published in 1923 and the last, representing the culmination of nearly 30 years' work, is now in the press.

Zoological science is indebted to Mortensen for many other contributions. A number of his papers deal with Ctenophora and include the description of a remarkable sessile member (*Tjalfiella*) which constitutes the type of a new family, the Tjalfiellidae. Among the papers published as a result of Mortensen's sojourn in the Pacific is one on protective adaptation; this deals mainly with marine animals, but also contains an account of 'pseudocephalic butterflies' in which, when the insect is at rest, the posterior ends of the wings simulate the head and tentacles, while the true head is concealed between the wings.

Mortensen was a vigorous advocate for the publication of the valuable series of handbooks on the fauna of Denmark, of which to date 56 volumes have appeared and to which he himself contributed the volume on Echinoderms. Its appearance prompted the late Prof. Stanley Gardiner to invite the author to prepare a similar treatise on the British Echinoderms; this was published in 1927.

After the 1914-18 war Mortensen was one of a number of Scandinavian Biologists who pressed for the establishment of an International Marine Biological Laboratory in the Malay Archipelago. In connection with this, Mortensen in 1932 visited the Kei Islands which he found to be almost unique as a site for such a station, with a very rich fauna and with deep-sea organisms flourishing in relatively shallow water where their study would be comparatively easy. Unfortunately funds have not yet been forthcoming to implement this very desirable scheme, but at the meeting of the Pacific Science Congress in Java in 1929, at Mortensen's instigation, the project was recorded as one of the important objects to be realized when circumstances permit.

It is a matter for very deep regret that Dr. Mortensen cannot be with us to receive the medal in person. A sufferer from *angina pectoris*, travelling, which has been one of the supreme delights of his life, is now impossible. In handing the Medal to Count KNUTH of the Danish Embassy for conveyance to Dr. Mortensen, I express on behalf of the Society our great appreciation of the valuable contributions Dr. Mortensen has made to biological science and the hope that his malady will not prevent his yet obtaining much of interest and enjoyment out of life.

In reply, Count Knuth expressed his profound appreciation of the honour that had been conferred upon his fellow countryman.

LIBRARIAN AND ASSISTANT SECRETARY'S REPORT

List of the Society.

Since the last Anniversary Meeting the Society has lost 36 members. The detailed statement follows :—

17 Fellows by death :

Rear-Admiral Tufton Percy Hamilton BEAMISH, C.B.
 Frederick James CHITTENDEN, O.B.E.
 William Thomas GORDON.
 Sir Sidney Frederic HARMER, K.B.E., F.R.S.
 Henry John JEFFERY.
 William Percy JONES.
 Sir Murdoch MCLEOD.
 Pierre Elie Félix PERRÉDÈS.
 Robert Brooks POPHAM.
 Christopher SANDEMAN.
 Mrs. Helen Holme SIMMONS.
 Field-Marshal Jan Christiaan SMUTS, P.C., O.M., F.R.S.
 Mrs. Beatrice STUART.
 Harold WALKEN.
 William WILLIAMSON.
 Ronald WINCKWORTH.
 Sydney Renoden WYCHERLEY.

2 Foreign Members by death :

Lucien CUÉNOT.
 Merritt Lyndon FERNALD.

2 Associates honoris causa by death :

Thomas William BURTON.
 Albert Harry HAMM.

15 Fellows by Withdrawal :

Hamilton BLACKISTON.
 Ernest St. John BURTON.
 Kenneth Thomas St. George CARTWRIGHT.
 Douglas DAWSON.
 Paulus Edward Pieris DERANIYAGALA.
 Cecil Stevenson GARNETT.
 Charles Adrian HOPKINS.
 Charles Norman Carlyle JAYAWARDENA,
 Frank Whitwam JONES.
 John McDONALD.

Alfred Samuel George MARDON.
Thomas Henry PARSONS.
Clifford Charles TOWNSEND.
Brian Seymour VESEY-FITZGERALD.
John WEBSTER.

During the Session 32 Fellows, 2 Foreign Members and 5 Ordinary Associates have been elected. The number of Fellows on the List is 779 with a further 21 Fellows elected but not yet qualified.

The Library.

Between 1 May 1950 and 30 April 1951, 42 books have been purchased, 116 parts of periodical publications and 49 reprints have been presented. During the same period the number of volumes bound was 372 and 256 volumes have been repaired.

The number of volumes borrowed by Fellows and Associates was 1520 and by the National Central Library 739. 674 signatures were recorded in the Library Visitors' Book.

The Linnaean and Smithian Collections.

During the past year the Collections have been consulted frequently, and many botanists visited the Society on their way to the International Botanical Congress held in Stockholm. Further progress has been made with the compilation of the Catalogue of the Smithian Herbarium.

THE PRESIDENT'S REVIEW

During the 163rd session, which is now drawing to its close, the Society has suffered grievous loss through the death of several Fellows of high rank and distinction. In November of last year we heard with deep regret of the decease of His Majesty King Gustaf V of Sweden, who had been an Honorary Fellow of the Society since 1909. We remember with gratitude that on 3 November 1923 the Society was greatly honoured by a personal visit from His Majesty, during which he signed the Roll and Charter Book on the emblazoned page of vellum specially provided. This historic event is commemorated by the framed photograph which shows His Majesty in the act of inscribing his signature and constitutes one of the treasures of the Society.

Another great loss to the Society has ensued through the death of Field-Marshal the Rt. Hon. Jan Christiaan Smuts, O.M., F.R.S., a man who, though playing a leading rôle as a politician and in the military field, yet found time to make important contributions to the knowledge of the African Flora. Among the several other Fellows, whose death has been reported, I would like to pay special tribute to the memory of Sir Sidney Frederic Harmer, F.R.S., President of the Society from 1927 to 1931, whose many notable contributions to zoological science made him a figure of great distinction. The Fellows have already recorded their sense of loss in a special resolution passed at the General Meeting on 26 October last.

The session has again been a fruitful one in the contributions made at our meetings to the advancement of biological science. Four of the General Meetings were Discussion Meetings. One of them, on the 'Taxonomic Treatment of Biological Races', was arranged in conjunction with the Systematics Association; another dealt with the breeding habits of fish. While both of these were full of interest, the other two relating to the nature and origin of man afforded the most lively interchange of diverse opinions. On 8 February Dr. J. W. Jones showed a highly interesting film illustrating the

spawning behaviour of the Atlantic salmon. At the first meeting of the session Professor McLean Thompson gave us another of his graphic descriptions of cauliflorous plants, and Dr. Manton's account of the locomotory mechanisms of the Arthropoda on 5 April stands out in my memory among the many important zoological papers contributed during this session.

The reception on 7 December was even more widely attended than that held in the previous session, and it is evident that this kind of gathering is much appreciated by the Fellows, both for the opportunity it affords of inspecting a variety of interesting exhibits as well as for its social value, and the possibility it offers of welcoming a number of guests. The film of the Scolt Head Bird Sanctuary, shown and introduced by Mr. John Chear, contributed greatly to the enjoyment of those attending the reception, and I should like to take this opportunity of once more thanking Mr. Chear on behalf of the Society.

The Council have invited Mr. I. H. Burkill to give the next Hooker Lecture, although at his request the Lecture has been postponed to the next session. Professor Harvey was appointed by Council to represent the views of the Society at the Public Enquiry into the proposed use of parts of Braunton Burrows for purposes of military training. I acted as your Delegate at the Eleventh International Congress of Limnology held in Belgium in August of last year, and was also your Representative at the formal opening of the new Laboratory of the Freshwater Biological Association on 23 September 1950.

In order to enable the Society to benefit by the recovery of income tax on annual contributions paid under seven year covenants, certain alterations in the bye-laws became necessary; these were balloted for and approved at the meeting on 5 April. May I express the hope that as many Fellows as possible will endeavour by signing such covenants to help materially to improve the Society's finances, without cost to themselves? Printing costs are continuously rising, and the Treasurer will probably tell you how difficult it will become to meet them without an increase in our resources. Two parts of Vol. 162 of the 'Proceedings', as well as one part each of the Botany and Zoology Journals, have appeared during this session, which has also seen the publication of the Lectures on Taxonomy delivered during the session 1949-50.

The session has been one foreshadowing several impending changes, involving the departure of old friends and the welcoming of new ones. Dr. B. Barnes, who acted as Deputy Treasurer between 1942 and 1944 and has been Botanical Secretary since 1944, has expressed his wish to retire and the Council have, with great regret, accepted his resignation. It is not the first time that I have been associated with Dr. Barnes and, even without experiencing his unstinted help during the two years that I have occupied the Presidential Chair, I should have been able to testify to the meticulous care with which he performs any duties which he agrees to undertake. His services were quite inestimable during the war years when he remained in London and often fulfilled more than his due share of the work of the Society.

Mr. S. Savage is another of those who is giving up his official position at the end of this session. He has long been a familiar figure in the Society's apartments and at its meetings, and he knows, without my saying it, how many of his friends will sorely miss his presence here. Always courteous and ready to give assistance, and with the Society's interests deeply at heart, he has helped in no slight measure towards the easy running of its affairs. During his long period of office as Librarian and Assistant Secretary he has prepared, apart from other contributions, a series of synopses of the manuscripts in the Society's library, and we hope that he will be able to continue with this valuable work, for which he is so well qualified, during the well-earned leisure that lies before him. The Council have made him a Life Fellow of the Society, and we trust that he will occasionally give us the pleasure of seeing him at our meetings.

His post, which will in future be called that of General Secretary, will be taken over by Mr. T. O'Grady who has been Clerk since 1935. The new Clerk is Miss M. P. Holberton, B.E.M.

At the last Anniversary Meeting I was unable to add anything to what my predecessor had said respecting the proposal for the accommodation of the Scientific Societies in a new centre. Since then, however, the position has become more clearly defined, as will be familiar from announcements in the press, and in particular from the excerpt of Sir Robert Robinson's last Presidential Address to the Royal Society which was published in 'Nature' last December. At the meeting of the Council of the Linnean Society on 12 October last our representatives on the Scientific Societies Accommodation Committee of the Royal Society were able to place before us particulars of the latest proposals. As a result of the discussion that took place on that occasion, the Council passed and forwarded to the Royal Society a resolution reaffirming their reluctance to relinquish their present accommodation, but accepting in principle the proposal that the Learned Societies should be accommodated at another easily accessible site, on the assumption that the Society would be given the accommodation previously specified as essential, and that the independence of the Society and of its Library would be fully preserved.

At the Anniversary Meeting of the Royal Society on 30 November 1950 the President stated that the nature of the negotiations with the Government had not admitted of that consultation of the Fellows of the Society which had been promised, and this of course places the Officers of every other Society concerned in the same predicament with reference to its members. It would certainly have been more in keeping with present-day practices if the general body of the Fellows had had an opportunity of expressing approval of a scheme which affects the future accommodation of the Linnean Society. I do not believe, however, that a negative attitude would, under the circumstances, have been possible. Nor is there any reason whatever to fear that our status as an independent Society will be in any way jeopardized or that we shall fail to secure quarters adequate for many years to come to house the Society's Library and Collections and to provide suitable accommodation for meeting rooms and offices.

It is not yet possible to divulge the position of the site, but I am convinced that it will meet with general approval. It is near the centre and readily accessible from other parts of London. The Treasury has agreed to bear the cost of the new buildings, and it is unlikely that the transfer will involve us in any considerable expense. The Society will have separate quarters and a separate entrance of its own, very much as in Burlington House. The site no doubt affords a great opportunity to the architect and there is every reason to believe that, to use the words of Sir Robert Robinson, 'the Scientific Societies will be housed in a worthy and impressive building, such a one as could look Somerset House in the face'.

There is of course no immediate prospect of implementing the scheme, but, as stated by the Lord President of the Council in the House of Commons on 21 November 1950, a start will be made as soon as resources can be found. In the meantime, however, the Scientific Societies Accommodation Committee are proceeding with plans and other preliminary arrangements, and we can rely on our representative on that Committee, Dr. Tindell Hopwood, to whom the Council have given plenipotentiary powers, to ensure that the needs of the Linnean Society are fully represented. Dr. Hopwood succeeds Dr. Malcolm Smith on the Accommodation Committee, and I should like to take this opportunity of expressing to the latter our gratitude for his manifold assistance in connection with the earlier negotiations.

In conclusion, I should like to express my thanks to all those who have assisted me during the present session in conducting the Society's affairs.

TREASURER'S REPORT

Printed copies of the Accounts for the financial year which ended on 30 April 1951 are before the Fellows. For comparison, the figures for last year are printed in italics on the left-hand side. A statement has been prepared by the Auditors who certify as to detail; the Audit Committee has inspected the books, verified the investments and bank balances and passed the Accounts; the action of the Committee has been confirmed by the Council.

I will briefly go through the accounts and deal with the main items:—

On the Income side the Admission Fees are lower due to fewer Fellows being elected than in the previous year, the Annual Contributions are about the same. The sales of publications are down on last year, but £603 is satisfactory. The Society again received from the Royal Society the sum of £750 from the Parliamentary grant-in-aid for Publications. Whilst we are deeply grateful for this great help to our funds for expenditure on publications, I should like to see our Fellowship come up to 1,000, this would enable us to carry on our publications without help. The Council has decided to place £500 to the Reserve for Publications leaving a balance in the General Account of £670. The cost of publications has increased this year to nearly £1,700. The Reserve for Publications now stands at £2,616 (see Trust and Reserve Funds).

Library Account.

The Account has a balance of £148.

Library Restoration Fund.

This Fund now has a balance of £1,195 out of £3,380 which has been subscribed. The binding and repairs to books has cost about £1,170 and the purchase of foreign works that were missing from our sets in the Library already amounts to £340. Further, £600 has been spent on extra shelving.

The Society has received donations of only £24 this year, and I should like again to appeal to all friends of the Linnean Library to help this Fund in any way they can, by donations or legacies, in order that this historic and valuable Library may be maintained and conserved.

Trust and Reserve Funds.

I have already mentioned the Publications Reserve, and the only other item that requires explanation is the Reserve Fund which was held to pay the balance of the cost of the new Central Heating System. This has now been expended.

Investments.

The main change in the General Account is the addition of £125 2½% Consols and £96 3½% War Loan 1952, which is the investment of the Composition Fees. There is no change in the Library Account. In the Special Accounts £100 New South Wales 3½% 1930/50 was redeemed and the money was re-invested in 3½% War Loan 1952.

Annual Contributions under Covenant.

Since our last Anniversary Meeting we have been in touch with the Income Tax authorities who have informed us that by virtue of its status, the Society is able to reclaim the tax paid by a Fellow on the amount of Annual Contribution paid under covenant, e.g. if a Fellow paying £4 Annual Contribution undertakes to pay the sum annually for seven years, the Society is able to recover £3 9s. 1d. per annum which has been paid as Income Tax on the gross amount. The Society has sent out a notice and form of covenant to all contributing Fellows not living abroad, and the Council hopes that Fellows will assist the Society by completing this Deed of Covenant. A number of

Fellows pay their Annual Contributions by Banker's Orders, and signing the Covenant will not disturb their present arrangements with their bank.

I wish to report a legacy of £100 left to the Society by Miss E. F. Noel, a Fellow of the Society.

I should like to thank Mr. O'Grady, our Clerk, for the excellent manner in which the accounts have been kept. Mr. O'Grady carries out the detailed work in keeping the accounts, and I am grateful to him for the conscientious way in which this work has been done.

If any Fellow wishes to ask any questions on these accounts, I will do my best to answer them.

(Presented at the Anniversary

Receipts and Payments of the Linnean Society

General

1949-50		RECEIPTS	£	s.	d.	1950-51	£	s.	d.
£									
		To Balance at 1 May 1950 :—							
		Current Account at Bank	702	10	10				
		Deposit Account Post Office Savings Bank ..							
		Cash in hand	6	11	5				
		Awaiting Investment	20	0	0				
613						729	2	3	
164		„ Admission Fees				96	0	0	
		„ Arrears of Annual Contributions	40	0	0				
		„ Annual Contributions for year	2641	1	8				
		Do. in advance	59	14	0				
2737						2740	15	8	
27		„ Do. of Associates				19	19	0	
281		„ Composition Fees				164	0	0	
335		„ Interest on Investments (including Income Tax recovered)...				342	9	10	
117		„ Do. Post Office Savings Bank Account				119	14	6	
		„ Sales of Publications :—							
		Transactions	24	4	0				
		Journals	414	16	2				
		Proceedings &c.	164	1	11				
717						603	2	1	
775		„ Grants in aid of Publications : Royal Society ..	750	0	0				
		Do. Mrs. E. W. Sexton	50	0	0				
						800	0	0	
74		„ Miscellaneous Receipts				33	3	4	
57		„ Transfer from Reserve for Publications Fund				430	11	1	
—		„ Bequest.—Miss E. F. Noel				100	0	0	
100		„ „ Miss I. M. Hayward							
100		„ „ D. J. Scourfield							
9		„ War Damage Account				1	0	0	
		„ Transfer from Reserve Fund				431	1	2	
£6106						£6610	18	11	

Library

£		£	s.	d.
295	To Balance at 1 May 1950	132	0	1
55	„ Interest on Investments (including Income Tax recovered) ...	85	4	3
10	„ Donation : Imperial Chemical Industries	10	10	0
—	Do. John Innes Horticultural Institution	10	0	0
250	„ Transfer from General Account	300	0	0
1	„ Miscellaneous Receipts	1	4	3
1000	„ Bequest.—R. J. Flintoff			
£1611		£538	18	7

Library

£		£	s.	d.
1884	To Balance at 1 May 1950	1712	18	10
54	„ Donations : Fellows and Friends	24	2	0
250	The Royal Society			
57	The Trustees, Imperial Botanical Conference 1935.			
£2245		£1737	0	10

Fellows' Postal

£		£	s.	d.
50	To Balance at 1 May 1950	50	6	5

YEAR ENDED 30 APRIL 1951

Meeting, 24 May 1951)

from 1 May 1950 to 30 April 1951

Account

1949-50		1950-51	
£	PAYMENTS	£ s. d.	£ s. d.
196	By Coal, Electric Current, and Gas	176 9 0	
49	„ Repairs : Sundry	750 15 0	
92	„ Taxes and Insurance	90 2 1	
223	„ Miscellaneous Printing and Stationery	276 10 2	
270	„ Petty Expenses and Postages	280 17 7	
	„ Publications :—		
	Printing	1566 6 9	
	Distribution	20 13 9	
	Illustrations	83 10 7	
1492		1670 11 1	
700	„ Transfer to Reserve for Publications Fund	500 0 0	
1580	„ Salaries and Wages	1580 4 11	
15	„ ' Zoological Record ' (Vol. 86) Donation	15 0 0	
—	„ Richard Spruce Plaque—Donation	1 1 0	
27	„ International Union for Nature Protection—Donation	2 2 0	
100	„ Staff Annuities (Annual Premiums)	62 10 0	
	„ Purchase of £125 17s. 6d. 2½ per cent. Consolidated Stock (Compounders' Fees)	90 0 0	
368	„ Purchase of £96 1s. 11d. 3½ per cent. War Loan, 1952 or after (Compounders' Fees)	91 0 0	
15	„ Linnean Medal	33 15 0	
250	„ Transfer to Library Account	300 0 0	
	„ Balance at 30 April 1951 :—		
	Current Account at Bank	173 4 6	
	Deposit Account Post Office Savings Bank ...	481 6 9	
	Cash in hand	12 9 10	
	Amount awaiting Investment	23 0 0	
729		690 1 1	
<u>£6106</u>		<u>£6610 18 11</u>	

Account

£		£ s. d.	£ s. d.
289	By Periodicals	157 14 6	
157	„ Binding	152 3 0	
32	„ Books	74 12 8	
1000	„ Purchase of £1414 7s. 11d. 2½ per cent. Consolidated Stock (Flintoff Bequest)		
1	„ Miscellaneous	6 2 1	
	„ Balance at 30 April 1951 :—		
	Current Account	48 6 4	
	Deposit Account Post Office Savings Bank ...	100 0 0	
132		148 6 4	
<u>£1611</u>		<u>£538 18 7</u>	

Restoration Fund

£		£ s. d.	£ s. d.
3	By Purchase of Foreign Works	344 4 0	
529	„ Binding and Repairs to Books	196 12 6	
—	„ Miscellaneous	10 3	
	„ Balance at 30 April 1951 :—		
	Current Account at Bank	24 4 1	
	Deposit Account at Bank	171 10 0	
	Deposit Account Post Office Savings Bank ...	1000 0 0	
1713		1195 14 1	
<u>£2245</u>		<u>£1737 0 10</u>	

Account

£		£ s. d.
<u>50</u>	By Balance at 30 April 1951	<u>50 6 5</u>

Special Accounts
(Trust and Reserve Funds)

RECEIPTS		PAYMENTS	
£	s. d.	£	s. d.
To Balance at 1 May 1950 :—		By Reserve Fund :—	
Westwood Fund	114 13 2	Transfer to General Account	431 1 2
Trail Award Fund	18 16 8	Reserve for Publications Fund :—	
Crisp Award Fund	135 6 8	Transfer to General Account	430 11 1
Hooker Lecture Fund	9 0 8	Staff Pension Fund :—	
Goodenough Fund	7 10 5	Purchase of £8 12s. 10d. 3 per cent.	8 12 9
Minehin Fellowship Fund	419 3 7	Savings Bonds 1955-65	
Carnegie Corporation Grant	431 1 2	Trail Award :—	
Reserve Fund	2546 11 11	Purchase of £1023s. 11d. 3½ per cent.	
Reserve for Publications Fund ..	15 0 0	War Loan 1952 or after	100 0 0
Deposit (Dr. A. H. Uggla)	3697 4 3	Balance at 30 April 1951 :—	
Transfer from General Account :—		Westwood Fund	125 10 6
Reserve for Publications Fund ..	500 0 0	Trail Award Fund	22 7 6
Interest on Investments (including		Crisp Award Fund	13 19 1
Income Tax recovered) :—		Hooker Lecture Fund	157 4 8
Westwood Fund	10 17 4	Goodenough Fund	17 13 4
Trail Award Fund	3 10 10	Minehin Fellowship Fund	10 10 5
Crisp Award Fund	13 19 1	Carnegie Corporation Grant	419 3 7
Hooker Lecture Fund	21 18 0	Reserve for Publications Fund ..	2616 0 10
Goodenough Fund	8 12 8	Dr. A. H. Uggla (Deposit)	15 0 0
Minehin Fellowship Fund	3 0 0		*3397 9 11
Staff Pension Fund	8 12 9		
Trail Award :—	70 10 8		
Amount received on redemption of			
£100 New South Wales 3½ per cent.	100 0 0		
Stock 1930-50	4367 14 11		

* Including £3328 6s. 9d. in Post Office Savings Bank.

Market Value
30 April 1951.
£ s. d.

General Account

£	s.	d.	
1000	0	0	3½ per cent London County Consolidated Stock 1958 68
1548	8	9	British Transport 3 per cent. Guaranteed Stock 1978-88
338	6	8	3½ per cent. War Loan, 1952 or after
1000	0	0	2½ per cent. Defence Bonds
2199	18	6	4 per cent. Australian Stock 1961-64
200	0	0	3 per cent. War Stock 1955-59
1139	13	0	3 per cent. Savings Bonds 1955-65
3134	3	9	2½ per cent. Consolidated Stock
176	19	3	3 per cent. Savings Bonds 1960-70
274	5	5	3 per cent. Treasury Stock
125	17	6	2½ per cent. Consolidated Stock
96	1	11	3½ per cent. War Loan, 1952 or after

Library Account

£	s.	d.	
471	18	9	British Transport 3 per cent. Guaranteed Stock 1978/88 (Bentham Bequest) ...
103	12	5	Surrey County 3 per cent. Stock 1961-66 (Wakehurst Bequest) ...
191	12	7	4 per cent. Australian Stock 1961-64 (Walker & Morey Bequests) ...
107	2	1	2½ per cent. Consolidated Stock (Stebbing Bequest) ...
530	0	0	3 per cent. Savings Bonds 1960-70 (Tagart Bequest) ...
1414	7	11	2½ per cent. Consolidated Stock (Flintoff Bequest) ...

Special Accounts

£	s.	d.	
£1063	10	7	Metropolitan Water Board 3 per cent. "B" Stock (Westwood Bequest) ...
			Ditto
			Ditto (Hooker Lecture Fund) ...
			2½ per cent. Consolidated Stock (Crisp Award Fund) ...
			" (Crisp Award Fund) (Goodenough Fund) ...
			" (Westwood Fund) ...
			" (Hooker Lecture Fund) ...
			" (Goodenough Fund) ...
			3 per cent. Savings Bonds (Staff Pension Fund) ...
			" 1955-65 (Staff Pension Fund) ...
			" 1960-70 (Minchin Fund) ...
			3½ per cent. War Loan 1952 or after (Trail Award Fund) ...

F. C. STERN, Treasurer.

We have (in conjunction with the Professional Auditors, who certify as to all details) audited the Accounts of the Society for the year ended 30 April 1951 and found them correct. We have verified the Investments and Bank Balances.

17th May 1951.

W. B. KEEN & Co., Chartered Accountants,
Finsbury Circus House,
Blomfield Street, London, E.C.2.

A. TINDELL HOPWOOD, W. E. SWINTON,
I. HENRY BURKILL, GEORGE TAYLOR,
FRANK W. JANE,

Audit Committee.

On a motion by Lt.-Col. R. B. SEYMOUR SEWELL, C.I.E., F.R.S., seconded by Mr. E. W. MASON the Report and Statement of Accounts were adopted.

The PRESIDENT then delivered his Address on 'The Evolution of a Differentiated Plant: A study in Cell Differentiation'.

PRESIDENTIAL ADDRESS

By Professor F. E. FRITSCH, F.R.S., P.L.S.

THE EVOLUTION OF A DIFFERENTIATED PLANT: A STUDY IN CELL DIFFERENTIATION.

(With Plate 29 and 52 text-figures.)

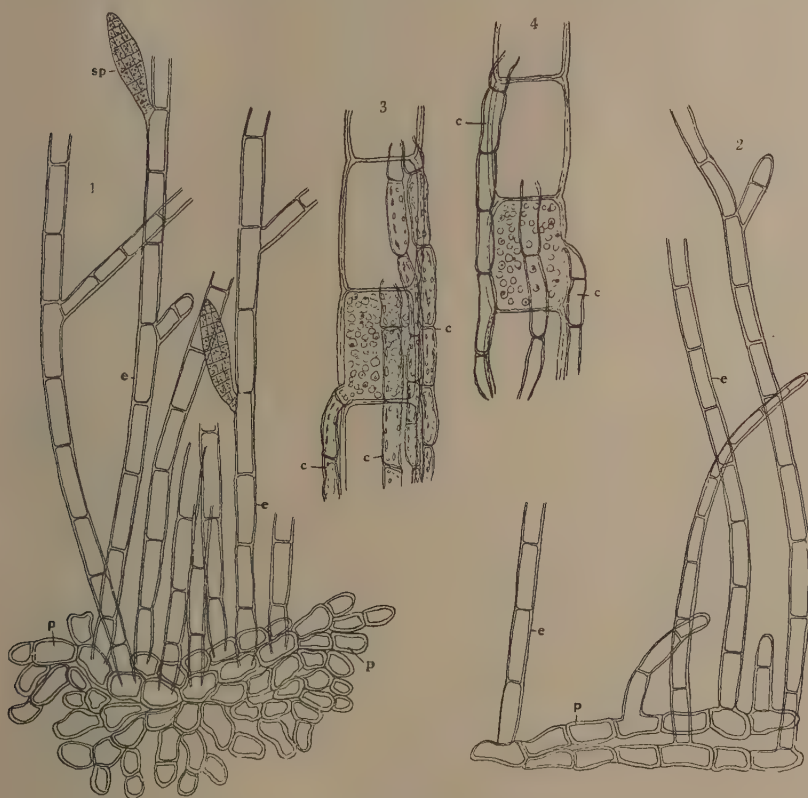
Among the diverse methods employed in endeavouring to trace the progressive differentiation that followed upon the acquisition of the multicellular habit, that of comparative study of existing plants has perhaps been most productive of positive results and, in the hands of such a master as Bower, has contributed much to our knowledge of the evolutionary history of ferns. Those investigations dealt with plants which have already attained a comparatively elaborate structure; but the comparative method can also provide excellent material for the tracing of early stages in cell differentiation, especially among relatively unspecialized forms. Such comparisons, moreover, help to shed light on the probable evolutionary sequence among these plants.

My object to-day is to deal with one such line of progression among non-vascular plants where it is possible to trace series of increasing complexity, and it is the brown seaweeds that furnish the materials for such a study. Here we find relatively highly differentiated parenchymatous types, as well as an assemblage of much simpler forms that provide us with progressive stages in elaboration. Whether the ancient rocks will ever disclose sufficient recognizable remains of this particular evolutionary series, to prove or disprove the correctness of the arguments I shall put before you, must remain an open question. Until then comparative study constitutes the only method of approach.

No one nowadays probably doubts that the first plants were one-celled organisms, from which, as a result of the failure of the cells to separate after division there arose filaments or other forms of simple multicellular plants displaying little or no differentiation among the cells. There is good reason to believe that, among such simple types of multicellular plants, there appeared at a comparatively early stage the type of structure which I have called a heterotrichous filament (Fritsch, 1929, p. 111), which is met with and often widely represented in all the major classes of the algae (Fritsch, 1939). I have given elsewhere (Fritsch, 1942, 1945) the cogent reasons for regarding this as the starting-point from which many, and perhaps all, of the more complex forms of plants originated and do not propose to dwell further upon these matters here. It must, however, be emphasized that in the majority of the less advanced Phaeophyceae, which are characterized alike by comparative simplicity of vegetative structure and unspecialized methods of reproduction, the life of the individual plant always starts as a heterotrichous filament (Fritsch, 1945 *a*, p. 50).

These brown algae, which I group as Ectocarpales (Fritsch, 1945 *a*, p. 49), include a very wide range of simple seaweeds, among which *Ectocarpus* itself appears as the most primitive. In many of the species the plant is a heterotrichous filament (fig. 1) and remains as such throughout its life. The first part of the alga to arise from the germinating zoospore or zygote, as the case may be, is an often extensively branched thread which creeps over the substratum (figs. 1, 2, *p*). The cells are well supplied with chromatophores, and this first formed

prostrate system at this stage carries on all the photosynthesis of the plant. From some or many of its cells there arise sooner or later vertically offstanding branches (figs. 1, 2, *e*), themselves often abundantly branched, and this erect system now takes over the major rôle in photosynthesis and usually also bears the reproductive organs (fig. 1, *sp*). It is unnecessary to dwell further on *Ectocarpus*, except to draw attention to two special features. Some species do not produce a prostrate system, but from the first give rise to an erect-growing axis. This is so in *E. granulosus* which displays its specialization also in the second feature, namely the outgrowth from the lower ends of the older cells of



FIGS. 1-4.—1, 2, *Ectocarpus* sp. (cf. *confervoides*), young plants; 3, 4, *E. granulosus* (J. E. Smith) C. Ag., older cells, with cortical threads (*c*). *e*, erect and *p*, prostrate systems; *sp*, plurilocular sporangium. (1, 2 $\times 220$; 3, 4 $\times 200$.)

numerous fine threads (figs. 3, 4, *c*) which grow over the lower part of the filament and often form a complete cortical investment around it. Both features are of some significance in relation to what is found in more advanced forms.

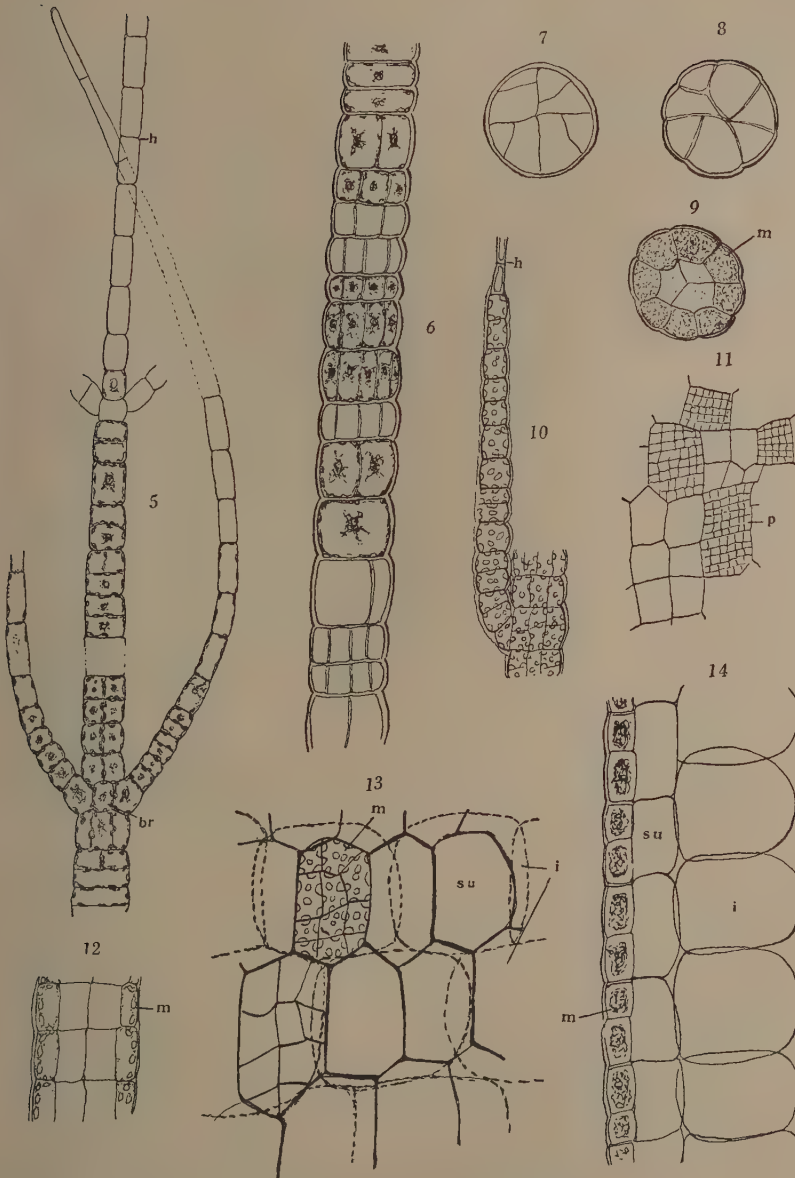
Starting from *Ectocarpus* it is possible to trace a multiplicity of evolutionary series among the Ectocarpales, but I propose to-day to select only a few examples from one of these, namely that in which progressive transverse and longitudinal septation of an erect thread results in a firm parenchymatous structure. *Phloeospora brachiata*, a small and rather rare summer epiphyte differs vegetatively but little from an *Ectocarpus*, in fact Harvey in his

'Phycologia Britannica' (1846, Pl. 4), referred it to that genus. In young plants (*cf.* fig. 5) the filaments often show only transverse septa, except in the cells bearing the commonly paired branches (*br*) which usually undergo some longitudinal septation at an early stage. Gradually more and more longitudinal septa, orientated in different planes (figs. 7, 8), appear in the cells in certain stretches of the threads, but these stretches are commonly separated by lengths in which the cells remain undivided (*cf.* fig. 6) and this is always so in the tips of the various branches (fig. 5, *h*). In places the longitudinal septation results in the formation of a central group surrounded by a layer of narrower cells (figs. 6, 9), but there is little differentiation between the two (Kuckuck, 1929; Mathias, 1935) and the cells of neither series usually divide further. *Phloeospora* is in fact one of the simplest parenchymatous brown algae existing at the present day.

A somewhat similar seaweed is the likewise epiphytic *Stictyosiphon* (Sauvageau, 1929, p. 287; Rosenvinge, 1935) where, however, septation of the embryonic thread is more extensive and soon leads to the differentiation of a surface-layer of cells with chromatophores (figs. 12, 15, *m*), surrounding a few larger ones (*i*) with scanty contents. During subsequent growth the surface cells (fig. 13, *m*) remain small, as they continue to divide by anticlinal walls and occasionally by a periclinal one (figs. 15, 16), while the inner cells undergo no further division. The often considerable surface growth leads, in the particular form I have studied, largely to a widening of the thallus-branches, the plants themselves remaining of small stature and possessing comparatively few branches*. As a result of the surface expansion the inner cells become more and more dilated (figs. 14, 17, *i*), and the contrast between the small peripheral (figs. 13, 14, *m*) and the relatively huge central cells (*i*, shown by the interrupted lines in fig. 13) becomes increasingly marked. In some forms like *Stictyosiphon tortilis* the inner cells may also undergo appreciable lengthening. The occasional periclinal division in the peripheral layer adds further cells to the central group (figs. 15, 17, *su*). Such tangential divisions are few in *Stictyosiphon* and do not seem to go beyond the formation of a single layer (figs. 14, 15, *su*) intervening between the surface one and the central large cells (*i*). In such a seaweed as *Scytosiphon*, however, they may be somewhat more numerous, and here several layers of cells may be found lying within the superficial meristematic layer, the outer later-formed ones being shorter than the more internal ones, as they have not been subjected to so much stretching (*cf.* fig. 18). The rapid growth of *Scytosiphon*, which is accompanied by copious anticlinal division in the surface-layer, leads to the separation of the inner cells so that the older thalli are fistular.

The two examples just considered exemplify tendencies which are more pronounced in the advanced parenchymatous Phaeophyceae, namely (*a*) the retention of a capacity for abundant division by the cells of the outermost layer whereby more or less considerable surface-enlargement is brought about and there are occasional additions to the inner cells, (*b*) the loss of the capacity for division by the inner cells so that they undergo passive elongation and widening by stretching. The cells of the surface-layer constitute the photosynthetic system, while the inner cells probably mainly serve for storage. The peripheral layer also fulfils protective functions, since the outer wall of the cells is often appreciably thickened (*cf.* fig. 27, *m*). It thus serves as a protective, photosynthetic and meristematic layer and may appropriately be

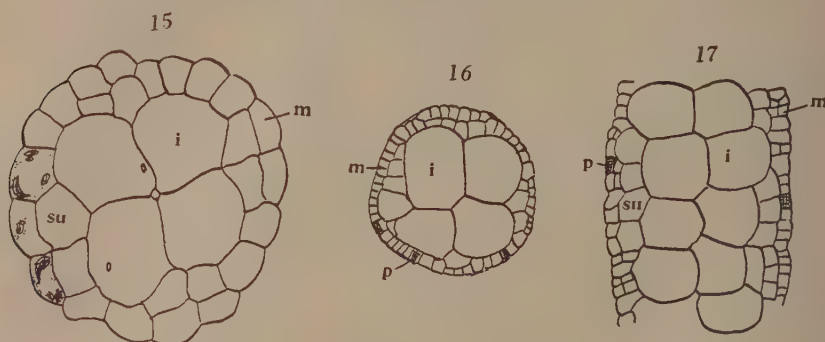
* The material in question occurred among the algal growth on the surface of submarines and other vessels in the Millport region of Scotland. The plants were only a few centimetres in length and not very richly branched, although the older parts bore plentiful plurilocular sporangia (fig. 11, *p*). So far as could be ascertained there was very great resemblance to the *Stictyosiphon Corbierei* described by Sauvageau (1929, p. 298), from whose account figs. 16 and 17 are reproduced.



FIGS. 5-14.—5-9, *Phloeospora brachiata* Born.; 5, apical portion of a young plant; 6, part of a mature thread; 7-9, various transverse sections showing the septation. 10-14, *Stictyosiphon* sp. (*Corbierei* Sauv. ?); 10, young branch; 11, surface of old part of thallus, with plurilocular sporangia (*p*); 12, longitudinal section of a young, and 14, of an older branch; 13, surface-view of older part, showing the three layers of cells (*m*, *su*, *i*), the surface-cells only shown on the left. *br*, point of branching; *h*, hairs; *i*, internal cells (interrupted outlines in fig. 13); *m*, meristoderm; *su*, hypodermal layer (heavy outlines in fig. 13). (5 $\times$ 230; 6 $\times$ 210; 7-9 $\times$ 290; 10, 12-14 $\times$ 345; 11 $\times$ 270.)

designated by the term meristoderm which Sauvageau (1918, p. 99) first applied to this layer in Laminariales.

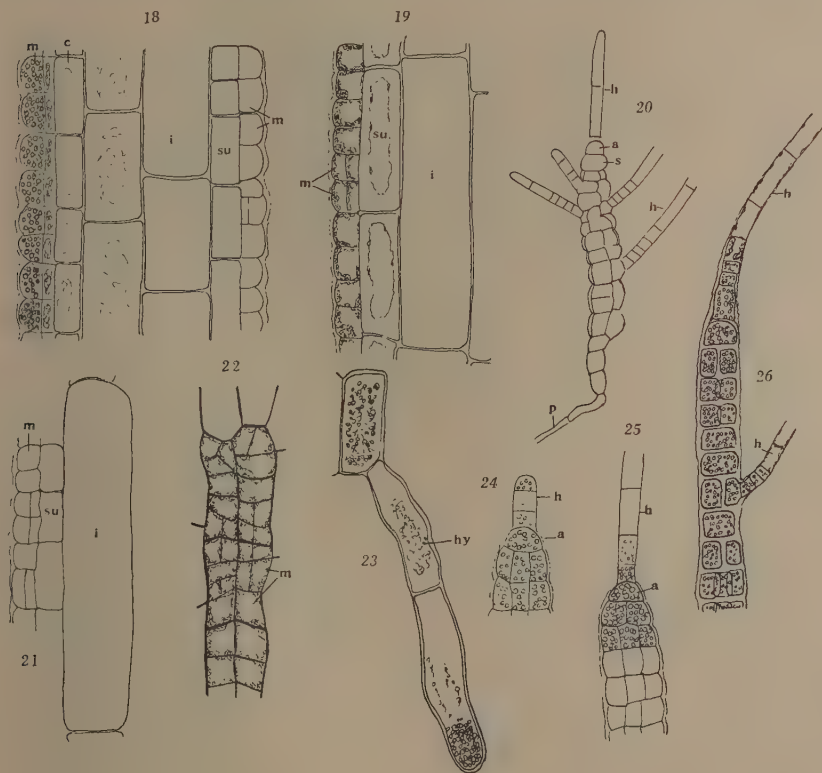
Both in *Stictyosiphon* and *Scytosiphon* the advance on *Phloeospora* is shown, not only by the greater bulk of the thallus and the evidence of differentiation among the cells, but is recognizable also in the primary heterotrichous stage, since the prostrate system takes the form of a comparatively firm and sometimes several-layered, disc, while the erect thread from which the mature thallus develops and which in *Scytosiphon* remains unbranched, undergoes longitudinal septation at an early stage. The short projecting column thus formed, both here and in other parenchymatous Ectocarpales, is commonly capped by a hair (cf. fig. 20, *h*) elongating by the division of a basal meristem, whose segments make little or no contribution to the underlying thallus. Whatever be the function of these hairs, which often occur abundantly also in a lateral position on the older parts (figs. 20, 26, *h*), their frequent presence at the summit of the embryo thallus is a striking feature.



FIGS. 15-17.—15, *Stictyosiphon tortilis* Reinke, transverse section of thallus (after Rosenvinge). 16, 17, *S. Corbierei* Sauvageau (after Sauvageau); 16, transverse, and 17, part of an optical longitudinal section of the thallus. *i*, internal cells; *m*, meristoderm; *p*, plurilocular sporangia; *su*, hypodermal layer. (15 $\times$ 340; 16, 17 $\times$ 155.)

They are met with in this position also in *Dictyosiphon* (Murbeck, 1900), the last of the Ectocarpales to be considered. This genus is one of the most specialized of the parenchymatous Ectocarpales in anatomical structure, as well as in other respects with which I cannot deal to-day. Whilst in the simple brown seaweeds previously discussed growth of the thalli is for the most part diffuse and never strictly localized at any one point along the longitudinal axis, *Dictyosiphon* exhibits apical growth of its many branches, at least during the early part of their life. As Sauvageau (1929, p. 259) has demonstrated, the apical cell appears early on the primary axis of the germling, whilst this is still capped by the hair (fig. 20 *h*). The young branches found on the older thallus (figs. 25, 26, *h*) often show the same feature, although some of these at least may have formed the hair after growth in length had ceased (cf. fig. 24). Sooner or later the terminal hair is shed and the dome-shaped apical cell then occupies the summit of the germling or branch, as the case may be. It cuts off parallel to its base a single row of segments (fig. 20, *s*) by whose subsequent enlargement and division the mature thallus is built up, much as in a *Stictyosiphon* (cf. figs. 18, 19). In many of the branches the activity of the apical cell is limited, most of the growth in length being due to the copious subdivision of the segments, a process to which the apical cell itself falls prey sooner or later.

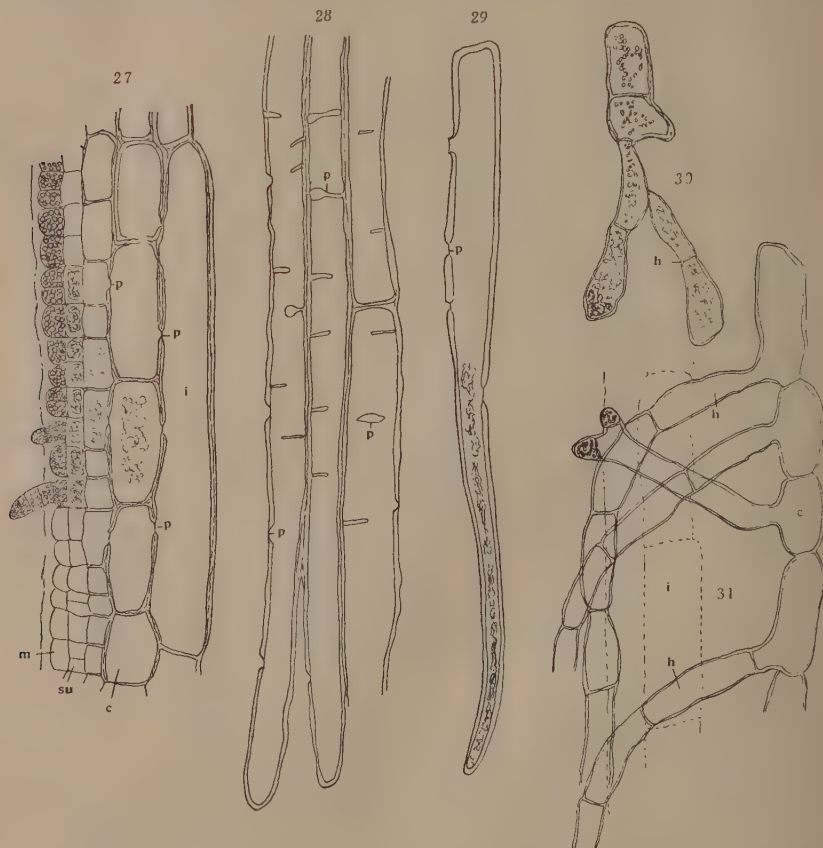
Plants of *Dictyosiphon foeniculaceus* may reach a length of half a metre. The superficial cells cut off by the first longitudinal divisions in the segments, as the latter lengthen and widen, divide by repeated walls at right angles to the surface so that these cells constituting the meristoderm (fig. 22, *m*) layer remain small. In the younger parts one can often detect, on inspection from the surface, a transversely banded appearance, since the meristoderm cells formed from a given segment of the apical cell are separated from those



FIGS. 18–26.—*Dictyosiphon foeniculaceus* (Huds.) Grev. 18, 19, 21, longitudinal sections of parts of thallus of successive ages, 21 being the oldest; 20, young plant (after Sauvageau); 22, surface-view, showing cells of meristoderm; 23, cortical cell, with hypha (*hy*); 24–26, apical portions of branches, with terminal hairs. *a*, apical cell; *c*, cortex; *h*, hairs; *hy*, hypha; *i*, internal cells (medulla); *m*, meristoderm; *s*, segment of apical cell; *su*, hypodermal layer. (18, 19, 21, 23 $\times 165$; 20 $\times 300$; 22 $\times 245$; 24–26 $\times 350$.)

derived from adjoining segments by slightly thicker walls. The cells of the meristoderm also divide by frequent tangential septa (fig. 21, *m*) so that several layers of internal cells are formed, as the cylindrical strands progressively widen. The innermost of these cells (figs. 18, 19, *i*) are appreciably elongated, even in comparatively young regions, and in the older parts may attain to a great length (fig. 27, *i*), being sometimes as much as thirty-five times as long as broad. This cannot be due to mere stretching, but must for the most part result from direct growth. These elongate elements have few contents and

relatively thick walls provided with slit-shaped pits which are quite irregularly disposed and in part of peculiar shape (fig. 28, *h*). I have seen no transverse septa in these elements, the ends of which are usually bluntly rounded, though sometimes gradually attenuated to a point (fig. 29). The innermost cells are pulled apart and ultimately disorganize in the lower regions of the thallus which become hollow.



FIGS. 27-31.—*Dictyosiphon foeniculaceus* (Huds.) Grev. 27, part of a longitudinal section of an old part of the thallus; 28, 29, medullary (internal) cells; 30, 31, hyphae arising from cortical cells. *c*, cortex; *h*, hyphae; *i*, internal (medullary) cells (interrupted outlines in fig. 31); *m*, meristoderm; *p*, pits; *su*, hypodermal layer. ($\times 210$.)

Surrounding these, ultimately almost fibre-like, central elements are the successively shorter ones, of more recent origin from the meristoderm, which may be described as cortex and appear typically parenchymatous in shape (figs. 18, 27, *c*). They, too, in the older parts undergo appreciable thickening of their walls which display prominent pits (fig. 27, *p*). As compared with the cells of the meristoderm and of the immediately underlying layer (*su*), those of the cortex usually possess comparatively scanty cytoplasmic contents, although in the lower parts of the axis they are commonly filled with rather plentiful storage substances. It is in these regions that many of the cells of the cortex put out

often elongate branching threads (figs 23, *hy*; 30, 31, *h*) which penetrate downwards among the other elements and play a part in forming the attaching disc at the base of the plant. According to Murbeck (1900, p. 22) similar, but seemingly rather narrower, threads arise in the basal regions of the larger branches and extend into the central hollow of the main axis. These diverse thread-like outgrowths or hyphae, as they are usually called, are no doubt homologous with the corticating threads described previously in *Ectocarpus* (p. 219) and also met with in *Stictyosiphon* (Rosenvinge, 1935, p. 14). Similar structures are widespread in Phaeophyceae and other algal classes, and probably in the main fulfil a mechanical function, although possibly also concerned in conduction.

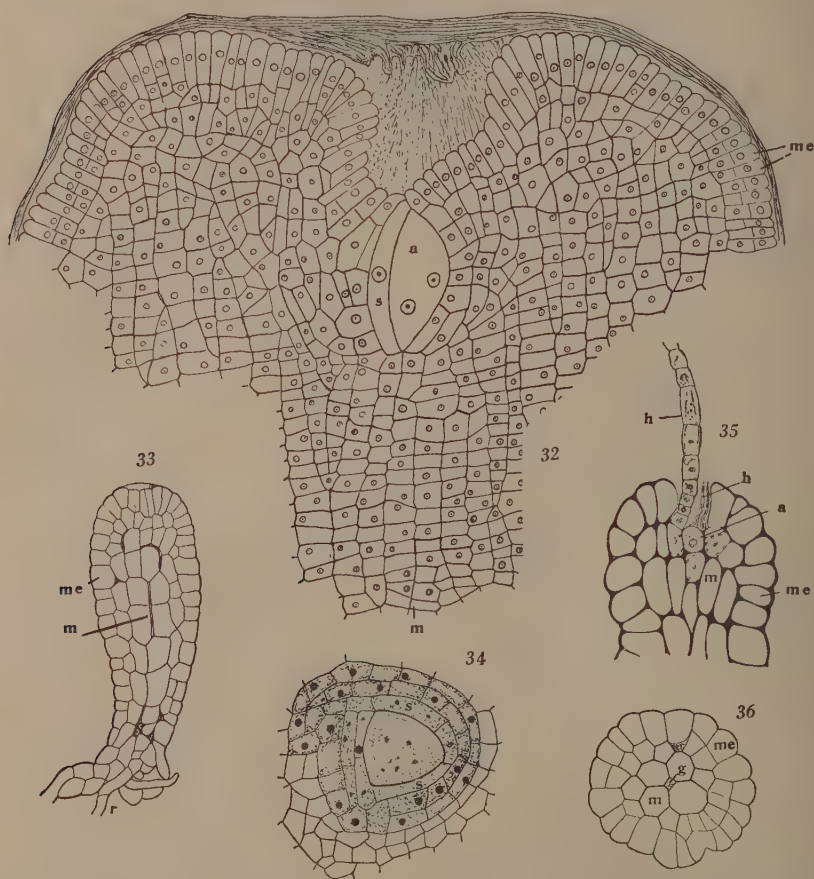
In the possession of apical growth, in the marked differentiation of the older thallus into meristoderm, a cortex of larger cells and a central region with greatly elongated cells, as well as in the appearance of pits and the production of hyphae in the older parts, *Dictyosiphon* has attained to a level of anatomical organization which in many respects foreshadows that met with in Fucales, the most specialized of the brown algae exhibiting apical growth. The gap between the forms we have been discussing and the Fucales is of course very wide, if the reproductive mechanisms and elaborate external differentiation of many of the latter is taken into consideration. The anatomical structure, however, of those Fucales which are not specialized for life between tide-levels, scarcely displays any intrinsically new features, although everything is on a much larger scale. There can of course be no question whatever of any direct origin of Fucales from present-day Dictyosiphonaceae, but to my thinking it is not improbable that the ancestors of the Fucales passed through a sequence of stages analogous to that I have traced out in representatives of selected Ectocarpales.

The ova of Fucales divide, soon after fertilization, by rather regularly orientated transverse and longitudinal walls to form a globular mass of cells, those adjacent to the substratum soon growing out into attaching rhizoids. As in all advanced algal groups, the heterotrichous condition, typical of the less specialized forms, has disappeared. Before long a contrast becomes apparent between the outer and inner cells (Oltmanns, 1889), the former (figs. 33, 36, *me*) dividing abundantly by walls perpendicular to the surface, whilst the latter (*m*) enlarge without much segmentation. As a result the embryo begins to lengthen (fig. 33). At this stage it is not unlike a young *Scytosiphon* or *Dictyosiphon*, though broader owing to its origin from a voluminous egg. The resemblance is heightened in *Fucus* itself by the appearance of first one and then other apical hairs (fig. 35, *h*) which are apparently lacking in most other Fucales. The outer cells (figs. 33, 36, *me*) also exhibit occasional periclinal divisions whereby additions are made to the inner cells so that by degrees one can distinguish in the lengthening embryo a central medulla of somewhat elongate cells (fig. 33, *m*) around which the meristoderm is progressively building up a cortical region.

Before such differentiation has proceeded very far, however, an apical cell appears at the top of the embryonic column and begins to play its part in building up the tissues of the thallus. It is probably of some significance and, in the present context, an interesting point of comparison with *Dictyosiphon*, that in *Fucus* (Nienburg, 1931) the apical cell (fig. 35, *a*) arises from the cell beneath the first of the afore-mentioned hairs (*h*) which soon wither. The apical cells* of Fucales are more complex than those of *Dictyosiphon* and are nearly always located at the base of a deep pit or furrow (fig. 32, *a*). They are in general

* The view has been advanced that such apical cells, and presumably also those of Dictyosiphonaceae, have originated by the lateral fusion of the end-cells of the threads of a multiaxial thallus. For this view, which was originally advanced by Schussnig (1938, p. 309) and has recently been supported by Böcher (1951, p. 18), no adequate evidence has ever been produced and, in my opinion, it would be very difficult to find substantial grounds in support of it.

large three-sided structures, not unlike the tetrahedral apical cells of many Pteridophyta and of mosses. The resemblance is particularly striking in transverse sections (fig. 34), which display clearly the three-sided character, whilst in longitudinal sections (figs. 32, 37, *a*) the apical cell usually appears more or less biconvex, though rather broader at the outer than at the inner end. The more elaborate form of the apical cell can perhaps be related to the more bulky

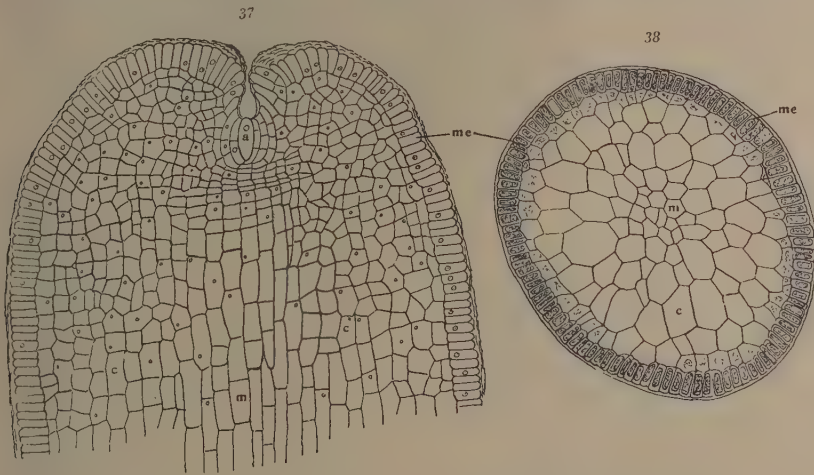


FIGS. 32-36.—32, 34, *Cystoseira* (*selaginoides* Valiante ?); 32, longitudinal section through apical cell and adjacent region; 34, transverse section through apical cell. 33, 35, 36, *Fucus vesiculosus* L.; 33, longitudinal, and 36, transverse sections through germlings (after Oltmanns); 35, apex of a slightly older germling (after Nienburg). *a*, apical cell; *g*, mucilaginous wall; *h*, hair; *m*, medulla; *me*, meristoderm; *r*, rhizoid; *s*, segment of apical cell. (32, 34 $\times 285$; 33 $\times 170$; 35 $\times$ about 290; 36 $\times 230$.)

construction, but the three-sided apical cell is so widespread amongst the less specialized plants that its presence is probably linked with more profound underlying organogenic principles.

There does not appear to be any fundamental difference in the mode of division of the apical cell in the various Fucales examined by me and others. In

Halidrys (Fritsch, 1945 *b*) and *Cystoseira*, the two genera which I have chiefly studied up till now, comparatively narrow segments are cut off successively (figs. 32, 34, *s*) from its three faces. These at an early stage divide by a number of perpendicular, as well as by more or less horizontally orientated, septa (figs. 32, 37) so that, as seen in longitudinal sections, curved rows of 3–5 cells result. The uppermost cell of each row lengthens to form one of the horizontally stretched elements lining the sides of the pit at the base of which the apical cell lies. The middle cells of the rows, which remain approximately isodiametric, help to build up the mound-like elevation surrounding the pit which also receives increments by the periclinal division of the cells lining the latter. The lower daughter-cells of each segment broaden somewhat and, with some further division, gradually assume a horizontal orientation. These elements give rise to the longitudinal files of flat cells which appear as a conspicuous horizontal plate (fig. 37) a short distance below the apical cell. Although this resembles a meristematic zone, its cells do not, for a time at least, undergo much further division.

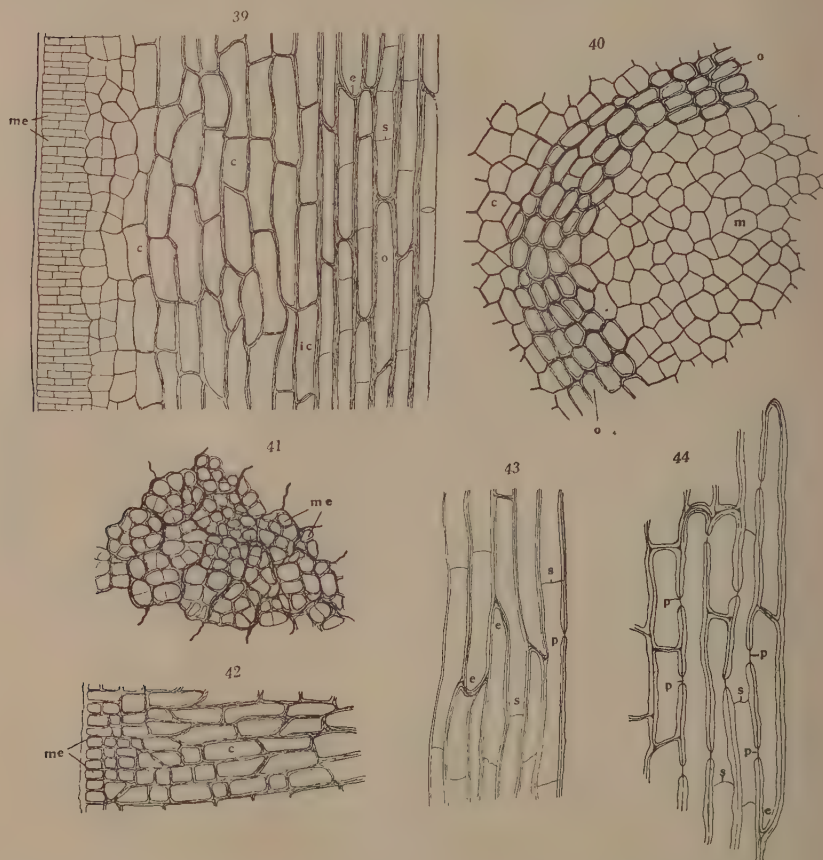


FIGS. 37, 38.—37, *Cystoseira granulata* Grev., longitudinal section of apical cell and underlying region. 38, *C. selaginoides* Val., transverse section of a small lateral. *a*, apical cell; *c*, cortex; *m*, medulla; *me*, meristoderm. ($\times 160$.)

They gradually lengthen and thus initiate the axial core of pronouncedly elongate elements which becomes conspicuous a little way below the apex and will in the following be spoken of as the medulla (fig. 37, *m*).

A short distance below the apex it is thus possible to distinguish, both in transverse (fig. 38 and Pl. 29, fig. A) and longitudinal (fig. 37) sections, three distinct tissues, which are essentially derived from the division of the segments, cut off from the apical cell. The periphery is occupied by a meristoderm (figs. 37, 38, *me*; Pl. 29, A, *m*), composed of rather short, palisade-like cells produced by repeated tangential division from the elongate elements lining the apical pit (*cf.* fig. 32, *me*). Beneath it lies a broad cortex (figs. 37, 38; Pl. 29, A, *c*), the cells of which generally show some thickening of their walls, but are still for the most part isodiametric, while the centre is occupied by the axial strand, figs. 37, 38, *m*; Pl. 29, A, *i*), the elements of which already tend to contrast with the cortical cells in their thinner walls and elongate shape. Although in the larger branches (Pl. 29, fig. A) cortex and medulla are far broader than the equivalent regions in *Dictyosiphon*, the differences between them

are of a comparable nature, while in the relative arrangement and distinctive features of the tissues, there is appreciable parallel in the subapical regions between such Fucales and mosses growing with the help of a similar apical cell. In the comparatively narrow short laterals, which are frequent in the species of *Cystoseira*, these resemblances are much more marked (*cf.* fig. 38).



FIGS. 39-44.—39, 41-44, *Halidrys siliquosa* Lyngb. (after Fritsch); 39, longitudinal section through lower part of a lateral; 41, surface-view of meristoderm (*me*) from a growing internode, with the outlines of the underlying cortical cells; 42, longitudinal section of meristoderm and part of cortex in basal region of axis; 43, part of a longitudinal section through the inner medulla; 44, part of section through a younger internode of the axis showing transition between cortex and outer medulla. 40, *Cystoseira ericoides* C. Ag., part of transverse section near base of a lateral. *c*, cortex; *e*, thickened end-walls of medullary cells; *ic*, inner cortex; *m*, inner medulla; *me*, meristoderm; *o*, outer medulla; *p*, pits; *s*, septa in medullary cells. (39 $\times$ 170; 40 $\times$ 180; 41 $\times$ 510; 42 $\times$ 250; 43, 44 $\times$ 360.)

As we pass from the subapical region to the older parts, however, certain differences become noticeable, differences which are the expression of those distinctive features of the organization of brown seaweeds, already noted in the simpler forms previously considered. They are the result of the activities

of the meristoderm, which contributes an appreciable share to the building up of the mature thallus. As in *Stictyosiphon* or *Dictyosiphon* the cells of the meristoderm divide actively by walls perpendicular to the surface so that throughout the thallus they remain small and palisade-like, appearing almost isodiametric when viewed from the outside (fig. 41), while even in longitudinal sections (figs. 37, 39, *me*) they are nearly always about twice as long in the horizontal as in the vertical direction. This extensive division leads to appreciable elongation, accompanied by some widening of the thallus-branches.

At the same time, however, the cells of the meristoderm exhibit more or less frequent divisions by walls parallel to the surface (fig. 39), whereby progressive additions are made to the extent of the cortex (*c*). In much of the thallus of a *Halidrys* or *Cystoseira* division of the cells of the meristoderm, by walls perpendicular to, is a good deal more frequent than division by walls tangential to the surface, and the newly-formed cortical cells tend to become almost at once drawn out in the longitudinal direction, most of them being 2-3 times as long as broad (fig. 39, *c*). The longitudinal tension induced by the often considerable surface growth, which also causes some tangential stretching, of course affects quite particularly the innermost and oldest layers of the cortex (*ic*) where the walls have become more or less appreciably thickened. Here many of the cells become tangentially stretched (*i.e.* somewhat flattened, fig. 40; Pl. 29, C, *o*) and very markedly drawn out in the longitudinal direction (fig. 39, *o*). There thus arises around the central, comparatively thin-walled medulla (fig. 40, *m*; Pl. 29, C, F, *z*), which was formed behind the apex and the elements of which are of course also undergoing lengthening, a progressively widening zone of mostly rather thicker-walled and often somewhat narrower elements which usually show a more or less marked concentric arrangement (Pl. 29, C, D, F, *o*). This zone, which probably fulfils a mechanical function, will be spoken of as the outer medulla. Though always present in the older parts, it is most easily distinguishable when its walls are appreciably thickened, as in fig. 40 and Pl. 29, B, C. Evidence of the longitudinal tension in the inner cortex and medulla in the older parts is furnished by the increasing obliquity of the first-formed septa (figs. 39, 43, *e*), as a result of which the elements often appear markedly dove-tailed between one another. Later-formed septa (*s*), recognizable by their thin character, are usually horizontal.

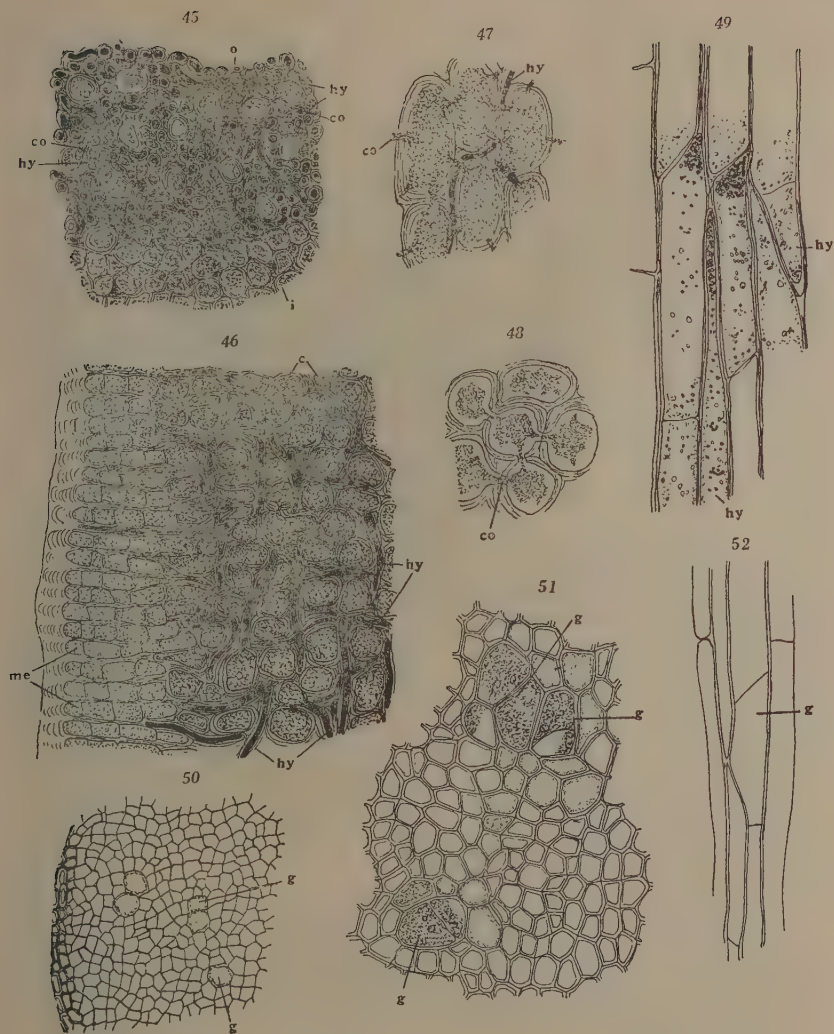
In the neighbourhood of the branches, which are frequent in the Fucales under consideration, the meristoderm of the parent axis often shows at certain points of the circumference more copious periclinal than anticlinal division so that its later-formed products remain horizontally elongated like the meristoderm cells themselves. Such rows of radially elongated and horizontally seriated cortical cells (fig. 42, *me*; Pl. 29, H, *m*) are also often found in the basal parts of the longer branches and in the main axes (fig. 46; Pl. 29, J), especially in the short sturdy ones which are usual in *Cystoseira*. They are in fact typical of regions where growth in length is slow.

The Fucales so far discussed show the structure which is characteristic for most members of the order and, in them, there is throughout the greater part of the thallus no appreciable production of mucilage. The cell-walls, though in the older parts not uncommonly quite markedly thickened in cortex and outer medulla (fig. 39), are firm and all the tissues are compact (Pl. 29, A, C, D, F) like those of an archegoniate plant. The great development of mucilage, which distinguishes the British Fucaceae living between tide-levels and which leads to marked distortion of the fundamental structure, is not typical of the order as a whole. It is to be regretted, and not only for this reason, that *Fucus* figures so widely as an elementary type, since an *Halidrys* or *Cystoseira* would display much more clearly the fundamental anatomical structure of an advanced Thallophyte, and at the same time portray the parallel with archegoniate plants.

The firm construction met with in most parts of the thallus of these two seaweeds is, however, subject to some modification in the older regions where hyphae tend to appear in increasing numbers. They occur near the bases of the longer branches and in the lower parts of the main axes, attaining an enormous development in the neighbourhood of the attachment-discs, in the formation of which they indeed play a major part. Occasional hyphae are frequently recognizable in the outer medulla in somewhat younger parts, where certain of the cells lengthen at one or both ends, the tapering extremities pushing their way longitudinally between the other elements of this tissue (fig. 49, *hy*) and appearing in transverse sections as smaller cells. Such hyphae may be much more abundant in older parts (fig. 45), but the main seat of hypha-production in them, especially in *Cystoseira*, is the cortex (fig. 46) and is always combined with, though not necessarily accompanying, the marked tangential division of the meristoderm and radial seriation of the outer cortical cells to which I have already referred (p. 229 and Pl. 29, H & J). In the older parts of the axes the branching hyphae (fig. 46, *hy*) run in all directions, many pursuing a radial and some even a tangential course (Pl. 29, J, *h*). Those, which run longitudinally, seem in part at least to extend from the axes into the bases of the branches. While in the present state of knowledge it is impossible to say which of several possible functions the hyphae fulfil, their formation in the forms under discussion is no doubt often intimately linked with the origins of the larger branches, and they probably serve to maintain some sort of connection between them and the parent axis.

The hyphae always traverse the thick walls of the cells of the cortex (figs. 46, 47, *hy*) and of the other tissues they invade and, when they are numerous, the cells become thrust apart. The protoplasts of adjacent cells, however, mostly remain linked by more or less numerous connections (figs. 45, 47, *co*) derived from the rather wide pits which are always present in some numbers in the thickening walls (figs. 43, 44, *p*). Such connections are indeed recognizable wherever the walls are strongly thickened (fig. 48). The cell-contents usually project into the pit-canals so that the protoplasts often appear somewhat stellate (*cf.* also Pl. 29, I, J, *c*), but the original pit-membranes are mostly still recognizable between the projections from adjacent protoplasts.

The increasing complexity, which is thus apparent in the older regions of the Fucales, finds still another expression in the species of *Cystoseira* I have examined. The medulla, which consists of greatly elongated, rather thin-walled elements with mainly pointed ends and occasional thin horizontal septa (fig. 52), is uniform in *Halidrys*, but in *Cystoseira* always distinguished by some difference in the width of the component elements (fig. 50; Pl. 29, C). In the basal parts of the longer branches and in the axes, however, there are usually present a number of elements which are conspicuous by their greater width (fig. 51; Pl. 29, G, *g*), being two or more times as broad as the remainder. These cells generally occur in a variable number of separate groups (figs. 50, 51, *g*), each comprising two or three of these broad elements. It is noteworthy that three groups, more or less symmetrically disposed within the medulla (Pl. 29, E, *g*), is a frequent condition. The number and arrangement of the groups, however, commonly displays very marked differences in transverse sections taken through closely contiguous levels, the cells in question being sometimes conspicuous in the one and practically indistinguishable in the other. As shown by longitudinal sections, this is due to the fact that these cells (fig. 52, *g*) assume their unusual width often only for comparatively short distances, dwindling both above and below to the breadth of the ordinary medullary elements. These wide elements are often densely filled (Pl. 29, E) with little vesicles and other bodies so that one may suspect a secretory function. However that may be, they are a practically constant feature of the medulla in the older parts of a *Cystoseira* and afford evidence of further differentiation which, so far at least, appears confined to the species of that genus.



FIGS. 45-52.—45, *Halidrys siliquosa* Lyngb. (after Fritsch), transverse section through part of medulla, near base of axis. 46-52, *Cystoseira*; 46-48, 50, 51, *C. selaginoides* Valiante (?); 49, 52, *C. granulata* Grev. 46, part of longitudinal section of axis, with horizontally seriated meristoderm and hyphae. 47, a few cortical cells, in longitudinal section, from the axis showing cross-connections and some hyphae. 48, a few cortical cells from base of a lateral in transverse section, showing thick walls and cross-connections. 49, outer medulla, with two hyphae. 50, 51, transverse sections through central medulla showing large cells (*g*), 50 somewhat diagrammatic. 52, longitudinal section of a little of the central medulla, showing a large cell (*g*). *c*, cortex; *co*, cross-connections; *g*, large cells of central medulla; *hy*, hyphae; *i*, central and *o*, outer medulla; *me*, meristoderm. (45 $\times 335$; 46, 52 $\times 185$; 47-49 $\times 220$; 50 $\times 150$; 51 $\times 210$.)

The description I have given of the structure of Fucales shows that, in the older regions of the plants, there is an appreciable variety in cell differentiation. Yet, in the younger parts, the same processes are operating as in a *Dictyosiphon*, the primary condition being derived from the segments of an apical cell, while later a secondary contribution is made by the activities of the meristoderm. It is essentially this feature that so markedly distinguishes the organization of the more advanced brown seaweeds from that of archegoniate plants. Why the surface layer in these forms should retain this striking capacity for division, and at one time divide mainly anticlinally and at another also by frequent periclinal septa, is a problem for the physiologist. There are manifestly many differences between it and the internal cells, apart from its direct contact with the sea water.

It is the copious anticlinal division of these cells that conditions the great surface growth and results in the marked tensions between the outer and inner tissues which are often readily demonstrable in the living seaweed. The conclusion that this is the sole cause of the great elongation shown by the inner elements is open to question, and it is more than probable that these may also lengthen by direct growth at their ends. There can be no doubt, however, that the tension induced by the rapid division of the meristoderm plays an appreciable rôle in achieving this elongation.

It is a long step from a *Phloeospora* or *Stictyosiphon* to an *Halidrys* or *Cystoseira*. Yet we have recognized in the two former the early beginnings of a differentiation, becoming much more marked in *Dictyosiphon*, that has led to the relatively elaborate structure of the Fucales. And so I hope to have shown that, by comparative study of a limited number of forms, we can pass by successive stages from the simple to the more complex and thus trace out the probable evolution of a differentiated plant.

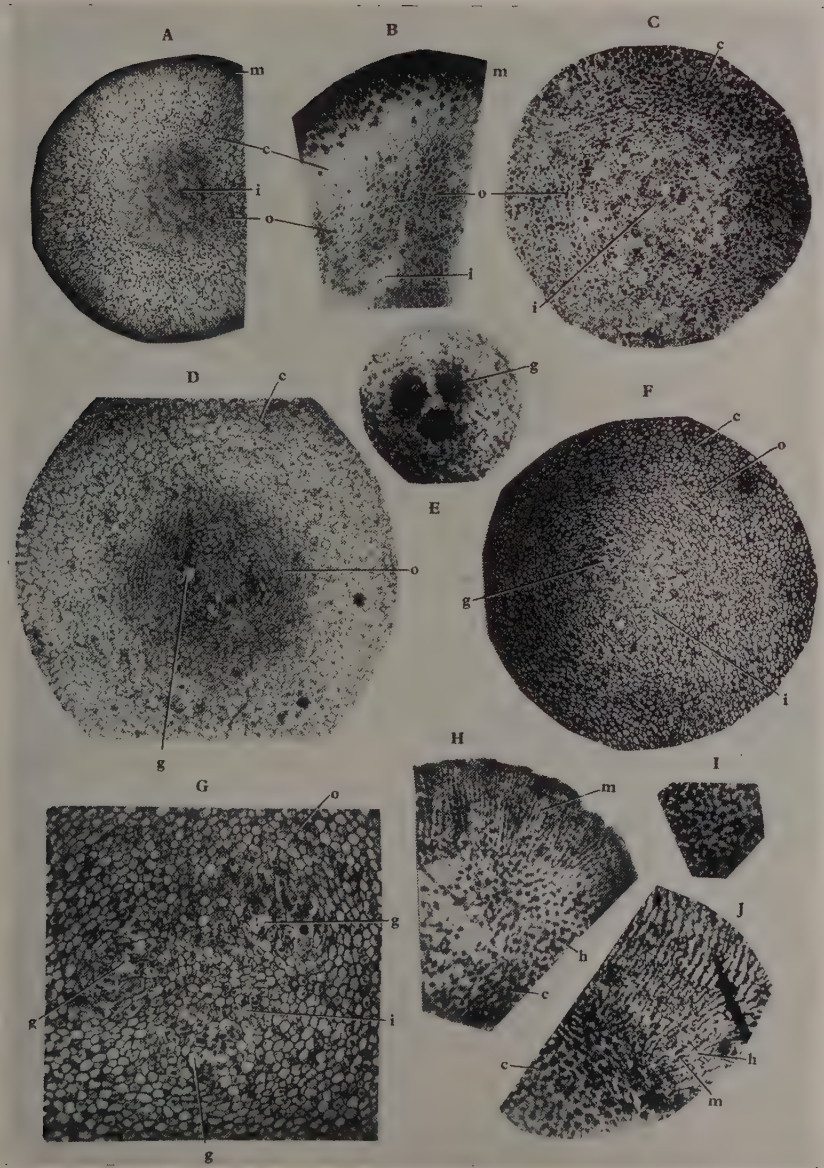
I am indebted to Dr. W. T. Mathias for the material of *Phloeospora* and *Dictyosiphon* from which the relevant figures were prepared, and to Mr. R. Cullen, Laboratory Steward, Department of Botany, Queen Mary College (University of London) for the photographs on Pl. 29.

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EXPLANATION OF PLATE 29.

Photo B is of *Halidrys siliquosa* Lyngb., all the others of *Cystoseira* spp.; A, D, E, H, C. *granulata* Grev.; C, C. *ericoides* C. Ag.; F, G, I, J, C. *selaginoides* Valiante (?). A, transverse section of a lateral in which the outer medulla (o) is yet little differentiated. B, small part of a lateral in transverse section, showing an active meristoderm at the surface, a comparatively narrow cortex, a broad outer medulla and a little of the inner medulla (i). C, D, transverse sections through the basal regions of long laterals showing concentric arrangement of outer medulla (o) and large cells (g) in the central medulla. E, central medulla from base of a lateral, showing three groups of large cells (g) with dense contents. F, section of bud-like lateral, showing large cells (g) in central medulla and



B is of *Halidrys siliquosa* Lynb., all the others of *Cystoseira* spp.

concentric arrangement of surrounding cells. *G*, part of the central part of *F*, more strongly enlarged. *H*, localized meristoderm-activity from base of a lateral, and *J*, ditto from base of main axis, both showing associated hypha-production; in *J* are seen numerous protoplasmic connections between the thick-walled cells of the cortex (*c*) (cf. also *I*). *c*, cortex; *g*, large cells; *h*, hyphae; *i*, central medulla; *m*, meristoderm; *o*, outer medulla. (*A-D*, *H-J*, $\times 32$; *E* $\times 26$; *F* $\times 20$; *G* $\times 40$.) Photos: R. Cullen.

On its conclusion, Professor F. J. LEWIS moved 'That the President be thanked for his excellent Address, and that he be requested to allow it to be printed and circulated amongst the Fellows'. The motion was seconded by Dr. JOHN RAMSBOTTOM, O.B.E., and being put to the meeting was carried with acclamation.

The PRESIDENT announced that he appointed the following as the Vice-Presidents for 1951-52:—Dr. B. BARNES, Mr. H. R. HEWER, Lt.-Col. R. B. SEYMOUR SEWELL, C.I.E., F.R.S., and Colonel F. C. STERN, O.B.E., M.C.

Thereafter the PRESIDENT declared the Session of 1950-51 closed.

A FURTHER CONTRIBUTION TO OUR KNOWLEDGE OF CAULIFLOROUS PLANTS WITH SPECIAL REFERENCE TO THE CANNON-BALL TREE (*COUROUPITA GUIANENSIS* AUBL.)

By J. McLEAN THOMPSON, Hartley Laboratories, Liverpool University.

(Plates 30-43.)

[Read 26 October 1950.]

INTRODUCTION.

While writing recently of *Swartzia* and of its flowering modes, I have remarked how Schimper claimed that when a Cannon-Ball tree begins to flower upon its sturdy trunk, the flowering shoots arise direct from sunken, surface-buds (1, 7). He thought the buds involved were formed in early sapling growth and stood first in leaf-axils upon the slender stem. His view required that most such buds were quickly brought to rest and, as the tree was forming, were sunken in its bark. He thought each added length of stem bore also resting-buds which, too, survived and could be found upon the broadening trunk. He claimed such trunk-borne buds give rise to all the flowering shoots and that the close-investing cork is ruptured as they lengthen. To meet the fact that flowering shoots spring, also, from the limbs, he claimed the latter also bear deep-sunken, surface-buds.

To gain a measure of the bud-reserve which Schimper thought existed, one need but watch a well-grown tree through following flowering phases and note at each where flowering shoots appear on trunk or limb. Most may arise between the stumps of many prior ones: some may be clustered, others raised on little broad-based domes. Some may be near or closely round quite old or recent stumps, and many may be single at intervening points. At each phase, stumps may be observed up to some definite height above which new shoots will appear at slowly rising levels along a length of trunk which shows no sign of prior flowering. Since flowering shoots may also spring quite low on lower limbs, the gap between them and the trunk-borne shoots may shorten steadily. The new shoots lengthened in a phase may number several hundred; and most of them may be in groups upon the lower trunk. As years advance and bring, in turn, their own new flowering phases, it may prove that the lower trunk is still in active flowering although the tree examined is known to be old.

Such observation may make plain that Schimper's claim required a vast reserve of resting-buds on any trunk which flowers, and that these buds should all be old before their rest is ended, now here, now there, throughout the years of active, rhythmic flowering. It does not seem, however, that Schimper tried to prove that sunken buds existed on trunks of any trees or that such buds form flowering shoots at any time or place. As will appear, his claim has now been tested fairly fully and is still unsupported by any evidence.

THE COURSE OF THE ENQUIRY : AND POINTS WHICH WERE CONFIRMED.

In 1920, I first searched for sunken, surface-buds on sheets of bark from trunks and limbs of trees of various ages. Three of these trees were said to be some forty years of age and to have been reared from seed near Kingston, in Jamaica (2, 3). The sheets examined were removed at monthly intervals : and, finally, I failed to trace a single sunken bud which might be thought a surface-bud around which cork had formed. Instead, internal buds were always seen beneath undamaged cork. These buds were in the living bark at very various depths ; and many stood in chambers which were entirely closed. The buds were often close beneath the current flowering shoots or in large groups which were remote from shoots of any length. These observations were resumed in 1934 when, also, seedlings and young saplings were seen in North Colombia (4). Once more, no sunken buds were found on any trunk examined though bark from young and flowerless trees was also used repeatedly. It was, however, verified from younger, flowerless trees that groups of buds in living bark are common on the trunks, and that these groups are underneath undamaged layers of cork. And lastly, while in Panama, in 1936, I saw large buds emerging from trunks of sturdy trees and proved they were the sources of many lengthening shoots. I noted that the cork is split before a bud emerges. Many of the slits were circular ; and, sometimes, little disks of bark were raised upon the buds or slowly thrust aside. Small sheets of bark were then removed and showed, when sectioned, that buds protruded singly had not been solitary but were the first within the groups to issue from the bark. And since, again, there were no signs of sunken, surface-buds, it seemed worth while to settle what buds could still be found on lengths of sapling stem preserved in 1934.

The distal lengths bore only successive surface-buds, related singly to expanded leaves, or scale-leaves, or leaf-scars. The buds upon the middle lengths were also superficial : some were in pits above leaf-scars, and larger ones were raised ; but all were clearly withered and most were suberized. The only buds which could be found upon the lower lengths were withered and distorted in outer layers of cork. Except along the topmost length, uninterrupted cork was spread beneath the buds and crossed their slender, twisted traces. Internal buds were not observed in any length examined. Thus it appeared that Schimper's claim entirely lacked support and that the view that parent buds of flowering shoots are old must now be reconsidered.

With this in mind, I then employed three oblong sheets of bark, taken from a young and flowerless tree in 1934. There were no stumps of flowering shoots upon the slender trunk or signs of buds emerging from smooth and glistening bark. The sheets were seven inches long and almost four in breadth. The upper margin of the first had stood at three feet from the ground. Six groups of buds, at distant points, were proved in it, within the inner bark. One group contained four large buds ; the others, two or three. Near to the buds, were little groups of very tiny cells, with boundaries so sharply marked that it was obvious that while some groups were spherical, most had a concave face. It was not known till later that little groups like these combine to form internal buds on trunks and lower limbs. The second sheet had been in place two feet above the first and showed it had internal buds at four adjacent levels. Small

single buds were recognized at three successive levels; and several groups of tiny cells were close around their bases. Three clustered buds were at the fourth; and, scattered widely round them, were many little groups of cells like those already mentioned. The upper margin of the third sheet had stood two feet above; the bases of some leafy shoots were only slightly higher. I failed to trace a single bud within this upper sheet: there were no groups of tiny cells at points in inner bark.

The bark examined was, at most, $1/40$ of the whole between the levels two feet five inches and seven feet from the ground; and 22 internal buds were in the lower sheets. When surface measurements of bark were used to help in estimation, it seemed that, at the least, 400 buds might well have formed upon the lower middle trunk, and all beneath a surface of almost five square feet. This estimate seemed moderate when it was known, later, that many of the buds in inner bark abort when flowering starts, and that, even then, the lower trunk may flower abundantly. Since sapling stems lose surface-buds wherever cork has formed, I had to think the internal buds had not been organized until the trunk had broadened and that, perhaps, their growth occurred in time- and space-successions. Also, I had to presuppose that, in the course of time, there would be bud-formation along the upper trunk.

To test these notions partly, I first examined records made from older flowering trees, and used some habit-features which had been well confirmed. It had been found that older trees may carry flowering shoots between the levels four feet and ten feet from the ground. When trees had leafy branches which drooped around the trunks, they did not bear new flowering shoots till some low branches fell. The highest new-formed flowering shoots were rarely far below the scars of branches which had fallen, perhaps a month before. The loss of branches had progressed in rough ascending sequence; and upper levels for new flowering shoots were raised repeatedly. Even when the trees had still retained most higher drooping branches, new flowering shoots surmounted the recent scars of branches and, frequently, still further shoots appeared round many scars which marked the points where branches fell in earlier years of flowering. It therefore seemed the flowerless trunk had only recent buds; that other buds would organize along its upper length; and that, in time, it would possess new-formed internal buds at points above the bases of many drooping branches.

The second test required, at least, that proofs should be secured of bud-formation in the bark of trees of various ages. It called for proof of all the steps by which the buds are formed and of the growth of flowering shoots from inner buds alone. This test could not be started till ample bark was studied. I therefore sought and had the aid of Holtum who supplied the needed samples of the bark and wood from trees in Singapore, and even bark from flowerless trees some fourteen years of age. He emphasized that flowering shoots appear at rising levels as loss of drooping branches occurs from year to year. He gave much information on growth and loss of branches and showed how trunks are lengthened as drooping branches fall. He also noted, later, that, when the young trees flowered, the first of all their flowering shoots were on the lower trunks and that, once lowest branches fell, still further flowering shoots appeared upon the middle trunks and at some points not far below the scars of recent branches. Also, I had the generous aid of Asprey who supplied both sheets of bark and lengths of branch from young trees in Jamaica. He noted seasons when the bark was cut and made it possible to study bud-formation upon a sturdy limb. An added debt is due to both of these collaborators for photographs which illustrate some striking habit-features.

The second test is now complete; and it is fully proved that buds are formed within the bark at many times and levels, and that the upper levels rise as trees increase in age. As will appear, internal buds provide all flowering

shoots, including those on major limbs which bear the leafy crowns. The course of bud-formation has now been fully traced, and steps in growth of flowering shoots have all been verified. This article will be concerned with facts which are confirmed ; but reference to several points is needed in advance.

The branches of a sapling are formed from surface-buds which all arose on slender lengths of hairy, current stem. Bud-bearing nodes are two years old when cork is formed on them and traverses the traces of buds which fail to grow. A sapling's branches lengthen through several years or more, and many droop around the stem and trail upon the ground. Most surface-buds on branches are in a state of rest until cork forms beneath them, when they are three years old.

The trunks of young trees lengthen by frequent increments until some younger branches extend precociously. These branches lengthen early on upward sloping courses ; and permanent limbs are formed from them when trunk-tips have been withered. All other younger branches assume a drooping habit, and some are lengthened steadily through ten successive years. Some distal lengths examined showed cork already formed on nodes which carried resting-buds which might be two years old.

Before young trees begin to flower, their lowest drooping branches show clearly that their growth in length has passed its final stage. The apical buds are shrunken ; and hypodermal cork is formed along the distal lengths as quite continuous sheets. It has been found that growth in length of higher branches ceases when they, in turn, are due to fall like older lower ones.

The state of lower branches may therefore indicate if buds are formed or forming on any flowerless trunk. The state of higher branches may lead to fair predictions of upper levels for new flowering shoots on older massive trunks. That flowering follows closely the death of drooping branches may mean this death is solely due to neighbouring bud-formation. I have, then, thought that older trees might still have drooping branches if flowering shoots were on their crowns, as in related plants.

The internal buds to be described are formed in special ways which are, however, partly matched in other flowering trees (2, 4, 5, 6), and have still further parallels in several gymnosperms. Some steps in growth are so remote from those in surface-buds that they create a contrast which calls for special notice.

A surface-bud has unity at every stage in growth ; its organs are exclusively the products of its apex. There is no question of some leaves it bears arising independently ; much less of small subtended buds existing from the first. Bud-axis is entirely a product of the apex although new tissue forms in it as active growth proceeds. There is no question which could rise of apex, leaves and axis combining in a surface-bud to cause its unity. Such questions are, however, raised by all internal buds which form at any levels on trunk and limb alike.

As will be shown, the large internal buds are always composite ; and many small buds are combined when any one is forming. Some of the steps need mention here ; and details are reserved until this article presents the proofs of all the steps in growth.

Before an internal bud is formed, small meristems arise at many points at several depths within the living bark. The meristems originate from nests of cortical cells which sub-divide repeatedly until each nest becomes a little mass of tiny cells which can divide again. The outlines of the meristems are so precisely marked that one might almost think their masses are engulfed in bark and clothed in parenchyma. Most of the meristems are very small and have a concave side. The remaining few are large and round and are at scattered points, but always have, as neighbours, some concave meristems. Wherever larger meristems have concave neighbours near them, large internal buds may be composed within the living bark.

As will appear, small buds are formed from many concave meristems : but bud-leaves and the growing points are seldom freed in chambers. Tangential sections of the bark will show that many smaller buds encircle every large bud so closely that it is the central member of a group of independent buds. The encircling members of a group supply an internal bud with all its tiny lateral buds, no matter what their numbers. It can be stated truly that all the buds involved are formed simultaneously within the living bark.

A large internal bud has outer 'leaves' which owe their total number to that of all the lateral buds which organized before them. They are, indeed, the last of all the organs to be formed, and also need some comment before the proof is given that they are not created as products of an apex, but are small strips of torn bark which seem, at first, adherent, as if cement united them along opposing faces. The separation of the strips begins in cortical cells above the 'central' bud and is continued downwards on spiral sheet-like paths which lengthen until lateral buds are passed to right and left. The lateral buds are then within the bases of the strips so that one might imagine that each bud was engulfed and was invested closely by large-celled parenchyma. The arrangement of the strips suggests a definite phyllotaxis like that of formed and forming leaves in any surface-bud. As will be found, I call these strips the *prophylls* of the 'buds' which first emerge from ruptured cork when flowering shoots are forming at any level on a trunk or on a sturdy limb.

The axis of an internal bud is formed by transformation of all the body of the 'central' bud and is not, then, produced by growth direct from growing-point, as in a surface-bud. To all intents and purposes, the growing-point is resting while active cell-division proceeds throughout the body which comes to be extremely large and often spherical. The axis is completed when cell-division halts except around the margins and near the lateral buds. Once lateral buds and *prophylls* and axis are combined, a large internal bud is formed within the living bark.

Some further points of contrast need also special mention since they arise in early steps of flowering shoot-formation. Before commenting on these points, I shall propose to call the base of an internal bud the active *pediment* since, as it proves, a flowering shoot is based directly on it and has a lower length which lies within the living bark and is produced exclusively by intercalary growth.

The growing-point is resting when shoot-formation starts ; but cell-division is resumed within the pediment. It is most active in the lower part, and even underneath, and comes to be continuous beneath the lateral buds. The pediment becomes, in fact, a special meristem ; and, soon, a cambium is organized beneath it and within it. Some products of the cambium are on its outer side : and since these product-cells enlarge and form a column of tissue, the *prophylls*, lateral buds and growing-point are raised progressively. Although the column lengthens by basal increments, it stays united to surrounding bark along its total length. The bark is damaged only above the uplifted *prophylls* since general cell-division begins around the column and is repeated, step by step, as lengthening proceeds. It will be shown that strands of bast arise within this bark and form a mantle to the column when growth in length has ceased. The column lengthens steadily until the bark and cork above the *prophylls* have been torn and all bud-organs rise through fractured cork and are exposed as one united group. The group is so compact and broad that one might well imagine a simple surface-bud is raised from mantling layers of cork. It will be found that woody strands are formed within the column when apical growth is started within the group exposed.

The final points of contrast which need some special mention relate to *prophylls*, lateral buds, and to some other buds, and to the freeing of the growing-points from all their covering tissues,

Although, at first, the lateral buds are in the prophyll-bases, it will be shown they come to be entirely superficial and placed in little 'axial' pits of various depths and breadths. These changes are prefigured when once a sloping split develops on a prophyll-base and towards the bud within it. The split is deepened steadily until the bud is reached and its small, flattened apex has been entirely freed. The split develops downwards so that a little flap of leaf-base tissue is defined and overhangs the bud. This flap is like the *ligule* which forms in many lycopods; and neighbouring bases separate before it is destroyed.

There will be proof that prophylls grow until they separate and that they shed their pointed tips when all have been exposed.

It seems the lateral buds remain in lengthy dormancy and play no part whatever in growth of flowering shoots. The flowering shoots arise direct between the expanded prophylls from growing-points with forming leaves and axial buds beneath them. The proofs of this will all be found in earlier articles which deal with flower-development in several allied plants (2, 3). Throughout the growth of flowering shoot, all lateral organs form as products of an apex, as in a surface-bud.

It will be found that many buds remain in independence and, seemingly, are resting at various depths in bark. They free their tips like lateral buds within the prophyll-bases: but prophylls are not formed with them at any stage in growth. Small flaps of tissue are detached above their apices and do not fall, but are destroyed by slow disintegration. In this respect, these buds resemble tips of compound buds which also have such tissues above their growing-points.

There are, then, many differences between the internal buds and surface-buds with naked tips at every stage in growth. In turning to the proofs required for points which have been raised, I should express some final views on all the evidence. They are that buds which now combine might keep their independence: that prophylls would not then be formed in bark at any time: that every unit bud might yield a flowering shoot directly if growth were active in its base and raised its growing-point: and that, if surface-buds remained on broadened trunks and limbs, they could be used in flowering, as in related trees.

SOME POINTS OF EVIDENCE.

1. *Some features of a sapling and of a flowerless tree.*

The evidence of saplings and young trees is required to underline some features of growing stems and branches and indicate where surface-buds exist on flowerless trees.

A sapling's stem is slender and tapered towards its tip. Its new-formed lengths are hairy and mainly rather long and have small awl-shaped lower leaves which seem to alternate. The larger leaves are crowded below the apical bud; and they expand together when growth in length subsides and scale-leaves have enveloped the broadened bud above them. The margins of the leaf-blades are very finely toothed; and slender downy hairs persist on nodes and internodes long after current leaves are shed and all their scars are sealed. The larger leaves are lanceolate and of most varied size, and each subtends a single bud which may produce a branch. Most of the lower buds are small, and very few are active: some grow to little slender twigs which are ephemeral. Persisting branches are derived from larger upper buds which lengthen rapidly before the stem has added to its length. New lengths of stem are furnished in every rainy season so that the growth of several years may make a sapling tall. The lower length of stem becomes a slender, upright trunk when all the first-formed branches are withered and have fallen. The trunk is clothed completely in smooth and thickening cork which covers also lower lengths of

all the higher branches which are retained upon the trunk and have thin woody bases. Sometimes, the remaining branches are lengthened intermittently, especially if new-formed stem is growing rapidly. The rate of branch-growth may be slow until the stem is tall : it is, however, evident there is a later stage at which the trunk-borne branches begin to lengthen rapidly in downward, drooping manner. The added lengths have larger leaves around their apical buds and carry single axial buds at all their nodal points. Most of these buds seem resting, and many die and shrivel when cork is forming under them in thin and perfect sheets (Pl. 34, fig. 22). Quite often, two new upper buds form side-shoots rapidly but grow more slowly than the branch-tips which are still dominant. Some single upper buds, on branches grown long, form side-shoots which grow actively and make the branches fork or come to be sympodial along their final lengths. Since many branches lengthen through ten or further years, their final lengths are straggling and trailing on the ground when young trees are established and trunks are growing broad (Pl. 30, fig. 1). While branches lengthen steadily, their apical buds are broad and have an outer covering of stumpy, awl-shaped leaves (Pl. 30, fig. 2). The larger leaves beneath these buds are of most varied size and are, then, like the distal leaves on sapling-stems and -branches (Pl. 30, fig. 3). While branches are in active growth, their current shoots are hairy, and apical buds are broadened as soon as they extend (Pl. 30, fig. 4). It is a sign that branch-growth is in its final phase if hairs are lost immediately when larger leaves expand and—as it proves—the new-formed shoot is quickly clothed in cork which is extended upwards above the petioles (Pl. 30, fig. 5).

The final state of branch-tips is better understood if they are sectioned lengthwise and tissues are examined. It will be found that apical buds are structurally perfect ; but even their smallest leaves are brown and partly suberized. Broad hypodermal cork will stretch along the full tip-lengths : but there will be no cambium beneath its inner layer. This cork is even formed along the topmost internodes and ends directly underneath the altered apical buds (Pl. 33, fig. 19). The skin of every internode is shed with all its hairs, as if it was a membrane which had been stretched and freed. The petioles of upper leaves are soft and fairly hairy : the axial buds are sometimes large or have already formed short spur-shoots with small, narrow leaves which are excised by cork (Pl. 33, fig. 18). If branch-tips have been sectioned in strictly transverse planes, broad cork will also be confirmed on all the upper nodes, as if extended round them from petiolar bases (Pl. 33, fig. 20).

Since recognition of this final state in lower trunk-borne branches can help to show if younger trees will soon begin to flower, the evidence of saplings is needed to confirm that tips of growing branches are in a different state. If tips of growing branches have fully elongated, thin sections through their lengths will show that compact cork has formed along the lower internodes which still retain their skin (Pl. 33, fig. 17). The upper limit of the cork on any lower internode will be below a small leaf-scar with rough and sloping surface. Above the scar—as shown now—will be a sunken bud which, like its nearer neighbours, appears to be at rest. The only cork which will be traced from high mid-points to apices is leaf-scar cork where smaller leaves had been the last to fall (Pl. 33, fig. 16). Even if the hairs have all been shed from upper middle internodes, their bases will be evident within undamaged skin as little groups of deep-stained cells at rather scattered points (Pl. 33, fig. 16). The topmost nodes and internodes will be extremely hairy as also will be covering leaves of all the apical buds. Whilst cork on branch-tips in their final state is formed once-for-all, when nodes of current branch mature, new cork is forming on them (Pl. 34, fig. 21).

I have not then considered that branches fail to lengthen at some chance time when they are old and have grown very long. It has seemed, rather, that

each fails to grow at some quite definite stage when flowering shoots are forming on the trunk below its woody base.

2. *Some tissues of a flowering trunk.*

Before attempting any proof of steps in bud-formation, I should refer to tissues on young and narrow trunks. The surface of a trunk is smooth since many layers of cork have formed without a fracture or gap at any point. The cork is lined by phellogen which yields internally a little tissue which matures as large-celled parenchyma, with intermingled stone-cells in groups of various sizes. This tissue's inner limits are never clearly marked: it joins the cortex to compose the narrow living bark. The underlying bast is broad and is continuous except outside the wood-rays where none is organized. Outside each ray, the cambium yields a mass of parenchyma which broadens outwardly and deepens by intermittent growth. This mass has no clear limits against the bast around it and merges imperceptibly with narrow covering bark. The total mass resembles an outward-widening funnel: the ray internal to it is like a funnel's tube. I call the mass a *ray-mouth* because of its position although it owes its origin, in part, to pericyclic tissue. To all intents and purposes, it comes to be a part of all the active living bark on any broadened trunk. Since larger ray-mouths come to be the matrices of buds, some tissue-changes in them should be, at least, confirmed.

3. *The transformation of a ray-mouth: and meristem-formation.*

The tissue in a ray-mouth is always parenchymatous until some meristems are forming within its outer region. It then becomes most obvious that narrow, curving cambia are organizing lengthwise and that, when they have formed, they will be like tangential sheets which cross the outer tissue. The tissue added by a cambium is formed centripetally so that adjacent cambia are rendered far apart except along the margins which may be confluent. Each mass of added tissue is more or less lenticular and makes a ray-mouth broaden more than deepen outwardly. The total mass may be matured as large-celled parenchyma without clear inner limits except where cells have swollen walls or have become compressed (Pl. 34, fig. 25, centre and left). When cell-formation ceases, a cambium is transformed to small-celled parenchyma with rather swollen walls (Pl. 34, fig. 25, centre). When any cambium has furnished internal rows of cells, the components of adjacent rows may subdivide repeatedly until a meristem is organized with definite size and form (Pl. 34, fig. 25, low right). A row of separate meristems may be the final product before their parent cambium has lost identity. If growing-point is forming for any meristem, it will be just above a group of small dividing cells which is apparent, always, before a bud is formed (Pl. 34, fig. 25, low right). A curved, lenticular meristem, four times as broad as deep, may be the major product of any cambium (Pl. 34, fig. 25, high centre). There may be several growing-points at well-spaced intervals above internal groups of cells which are in subdivision. A large lenticular meristem, is, later, subdivided when radial sheets of little cells between the growing-points have broadened greatly and mature as large-celled parenchyma.

New cambia are organized in tissue formed by others and also in a widening field which may be bi-convex and does not seem to change its shape until some buds are formed and cause distortion of the tissue around and over them. The locus of a widening field is easily conceived if one imagines that a funnel's rim is covered by a lens which blocks the entrance fully and fits it perfectly.

The new peripheral cambia are often far apart so that there are, between them, broad bands of parenchyma. Although they are convergent, they may remain apart or have their margins confluent at rather distant levels. It seems that few are active in forming outer products and that some fail to function and change to parenchyma with swollen outer cell-walls to mark their

transformation. Since single meristems are organized mid-way between these cambia, the intervening tissue appears to be their source.

4. *A field of meristems : and the origin and features of compound buds.*

While meristems are forming throughout a broadening field, parts of the matrix-tissue are growing intermittently. They may be deep within the field or near its spreading margin, but show no sign of cambia at any stage in growth. The component cells of any part divide and then enlarge and may divide again until a bulging tissue-mass is fully organized. No matter what its shape or size when general growth subsides, each mass is parenchymatous and has its outline fixed by broadened, twisted cell-walls in one continuous sheet. Each mass becomes a minor field which yields a group of meristems : these come to be a system which may compose a bud. Most of the members of a group are small and almost ovoid and are arranged most orderly around a 'central' one which is, most often, very large and is a perfect sphere (Pl. 37, fig. 34). Each little meristem is in a zone where growth was concentrated so that the final limits of all the zones are marked by sheets of plastic cell-wall which broaden as they stretch (Pl. 37, fig. 34, 1-6). The sheets are curved and, when complete, are confluent in pairs so that each pair encloses a mass of parenchyma from part of which a meristem has organized directly. Each of the little meristems in bounded parenchyma has flat or concave inner face directed towards the sphere. More distant members of a group may be in bounded tissue but may have concave faces turned to right or left, or outwards.

Since single sections cannot show how many little meristems are grouped around a sphere, I should attempt to visualize a common type of group which has been proved repeatedly through serial transverse sections.

One may imagine that the sphere—with parenchyma round it—is in a tiny urn and fills its cavity. The urn-wall imagined is multi-laminate, consisting of curved, leaf-like sheets arranged like leaves on a spiral so that the tips of outer sheets define a narrow entrance which is, however, fully filled by large-celled parenchyma. To follow any single sheet from base to narrow tip would need a circuit of the urn before the tip is reached. One may conceive that each sheet-base contains an ovoid meristem and that, whilst bases of the inner sheets are close around the sphere, those of the outer sheets may be quite high upon the wall. Thus if the urn was cut across in any lower plane, the section would traverse the sphere and every inner sheet-base and, at the least, some meristems which were in inner bases (Pl. 37, fig. 34). Cross-sections at most higher levels would show some outer bases and several outer meristems and, also, lengths of many sheets which help to form the wall.

Comparison of many fields has made it evident that only independent meristems arise in any field until some minor fields are formed within its own confines : that, where a minor field exists and yields a group of meristems, some members of the group will constitute a clear and ordered system : that every system will comprise at least one massive sphere and smaller lateral meristems in leaf-like sheets of tissue which all supply the prophylls of massive compound buds : that apices of compound buds are formed direct from spheres : and that the smaller meristems mature as lateral buds. The total product of a minor field may be a single bud which shows, in mid-long section, some lengths of curving prophyll (Pl. 37, fig. 35, P) and several lateral meristems enclosed in prophyll-bases, and with their concave faces towards the apex of the bud.

5. *Some points of variation.*

When many independent meristems have formed in a field, it is no longer easy to judge which may be old since no one can determine where cambia had existed or judge which tissue-boundaries were recently defined. It is, however,

certain that many separate meristems enlarge until they are like small imperfect saucers which often have vague, incurved rims and rugged inner faces. Their faces may be fully freed from pegs of parenchyma or may be parted from them at only single points (Pl. 39, fig. 40). Still further meristems form domes or mounds which fail to free their surfaces (Pl. 39, fig. 41, A), whilst others are arrested as narrow sheets of tissue with torn chambers over them and widened outwardly (Pl. 39, fig. 41, B, C). Some other meristems are very large and have small, rounded neighbours which are, most often, scattered without a sign of grouping. The common products of the large spheres are buds of various sizes with rim-borne, leafy outgrowths around flat growing-points. The growing-points and outgrowths are always freed together by simple separation from covering parenchyma (Pl. 38, fig. 37, B). A rounded neighbouring meristem may be in bounded tissue, suggesting that a lateral bud and prophyll might be formed (Pl. 38, fig. 37, M) and could then join a neighbouring bud and end its unity. Most of the small, round meristems mature as tiny buds which always have their growing-points upon their outer faces, but rarely free their outgrowths from covering parenchyma.

Thus any field which has enlarged by many steps in growth contains not only compound buds and independent meristems but also numerous unit buds of very varied sizes. The field is intersected by sheets of broad cell-wall which pass between the meristems and curve around the buds and may persist till after some compound buds enlarge and flowering-shoot development has started in a field, and woody strands are forming beneath the major buds (Pl. 36, fig. 33, L and S.S.). Some further features of the compound buds are worthy of attention since they affect the unity which is conferred on them.

When any minor field is cut in serial transverse sections, all meristems within it can be reduced to plan so that their sizes and their forms and spacial relationships may be considered and compared with those in other fields. Curved lines may represent the sheets of broadened, bounding cell-wall, and blackened curving masses the lateral meristems with inner faces turned towards a massive sphere or apex (Pl. 36, fig. 31, A, L). The final product of the field now shown would be a unit bud, with apex not quite central (L), and with some lateral buds and prophylls quite close around the apex, and others distant from it. Such compound buds are common and, often, of great size and may possess from 60 to 80 lateral buds.

The meristems in minor fields may not be simple systems with single spheres as focal points for all the lateral meristems. The spheres may number three or four and be of equal size, or one may be much larger than others in the field (Pl. 36, fig. 31, B, 1, 2, 3). Each sphere is then a focal point for smaller neighbouring meristems so that, whilst few have inner faces towards the smallest sphere of all, the larger spheres are focal points for all remaining meristems. Three compound buds of different size could be the final products: the apices of larger buds would, clearly, be eccentric (Pl. 36, fig. 31, B, 1, 2). Such groups of compound buds are formed in many minor fields. Most commonly, the largest buds become the active leaders and others are sub-ordinates, with some delay in growth, when flowering shoots are forming on trunks of younger trees.

6. *The fields with buds and meristems.*

When broadened ray-mouths have been cut in virtual radial planes, they may show some examples of little buds which formed from rounded meristems, and also little meristems which could form further buds (Pl. 36, fig. 33, B-B and M-M). The margins of an active field may not be very evident but will be near such levels as are numbered 1 and 2. The bast around a ray-mouth will be in parallel strips (PH-PH), and many nests of stone-cells will be in inner bark; and sheets of stone-cells will have formed not far beneath the

cork (solid black). The prophylls of a leader-bud (L) may all have freed their surfaces within an irregular chamber which has been fully opened to outer air and light by tearing and destruction of covering bark and cork. This freeing of the prophylls is, doubtless, premature and seems to be related to cambial activity beneath the bud and to arrest of growth within its body which would provide a pediment if flowering shoot were forming. The cambial zone is very deep; and many layers are active and, thus, envelop inner buds and little meristems which chance to lie within it or near its widening fringe. It furnishes fine, woody strands which link, internally, with many others organized when leader-buds were formed but had no vasculature around their broadened bodies. Each body comes to have a fringe of fine tracheidal strands (L and S.S) and, later, has procambial strands around its central massive of very tiny thin-walled cells which seem to be at rest (Pl. 34, fig. 23). Some prophylls are distorted or partly suberized whilst others may be tender and hairy near their tips (Pl. 34, fig. 24). The lateral buds are shrunken, distorted, and displaced but may be evident, from time to time, close to the prophyll-bases (Pl. 34, fig. 23, right). It seems that many leader-buds fail at this stage in growth but that their structure is unchanged through several years, or more. At least a few are later clothed in narrow sheets of cork and thus remain near little buds which rarely gain in size and never fracture covering bark or grow to flowering shoots. It should, then, be confirmed how normal growth proceeds and, first, how lateral buds are formed, and that they are unchanged until the prophylls separate when they are carried outwards through bark and fractured cork.

7. *The formation of lateral buds and prophylls.*

As has been shown, a massive sphere has meristems around it wherever any compound bud is forming in a field (Pl. 37, fig. 34). Full serial sections make it plain that tissues on the inner sides of many lateral meristems mature as parenchyma, and that the tissues on the outer sides provide the forming buds (Pl. 37, fig. 34, 1, 2, 3, 5). The total parenchyma formed is sometimes clearly shown (Pl. 37, fig. 34, 1, 2, 3) but cannot be determined by well-marked boundaries when outlines of the prophylls are fairly evident. Wherever massive compound buds are forming in a field, cross-sections show some stages in growth of lateral buds (Pl. 38, fig. 38). The arrow gives direction towards the centre of the system. Two outlined prophyll-bases are crossed at B and C. The bud in B is traversed in almost median plane and shows, in full, the form and state attained by lateral buds until the prophylls have been freed and they have been exposed. It has a small, flat growing-point and broad, incurving rim and is united fully to large-celled parenchyma. The forming buds in A and C are traversed towards their margins: each has an indentation where growing-point will stand: beside the forming bud in C is inner parenchyma which fills the indentation and clothes the inner face. Thus, as components of a compound bud become coordinated, the lateral buds are organized in no precise succession until they all have growing-points and broad, incurving rims. Even when the apex of a compound bud is freed from covering tissue, the formed and forming lateral buds are clothed in parenchyma (Pl. 37, fig. 35).

8. *The uplifting and exposure of the organs of compound buds.*

I should revert to features shown in fig. 33 (Pl. 36) and notice that, although the local cambial zone is under major buds, it could embrace and modify the bases of their bodies and still yield many strands of wood like those which are below them. Since these conditions are fulfilled in many broadened fields, the organs of the major buds remain beyond the cambium and are all still united to unchanged upper parts. Fine strands of wood are organized from inner cambial products; and since the cambium is active in forming outer products, the organs of the buds are raised in measure with its growth.

Surrounding bast is plastic and can allow for growth and is assisted in this by local cell-division. The organs of a group of buds are, therefore, raised directly until their final barrier is broadened, covering cork. The cambium continues to furnish outer products until the cork is ruptured and organs of a leader-bud are partially exposed, whilst those of the subordinate buds are still within cork. The organs which have been exposed are closely overlapped so that one might imagine a sunken bud has risen through mantling cork or has been perched upon a cork-clad dome (Pl. 31, figs. 7, 8). The growing-point and outer prophylls of a major bud are hidden in the rupture which is extending downwards to varying depths in outer bark and, thus, defines a tissue-column within the outer bark, with prophyll-bases on it, in one ascending sequence. In contrast to the organs which suffer great displacement, the bases of the major buds rest more or less in place, although they have been altered to portions of the cambium, and early form and structure are totally effaced. Each has, however, founded a heightening tissue-mass and adds new tissue to it so long as growth proceeds. It is the active pediment from which the mass arose and has, throughout, been adding most to underlying bark.

9. *The initiation of flowering shoots : their vasculature and new fields for meristems.*

A ray-mouth broadens greatly if major buds within it initiate young flowering shoots through active apical growth (Pl. 42, fig. 47). The breadth of ray-mouth shown extends from M^1 to M^4 . The field is very shallow and rich in marginal meristems which, mainly, are aborted or have remained at rest. The major buds were central and were in place, at first, between M^2 and M^3 and, doubtless, at the level of these two lettered points. The lower length of upright shoot (L) protruding from the cork (solid black) is clothed in little 'leaves'. These are the prophylls of the leader-bud from which the shoot arose. Their surfaces are mainly freed ; but all the outer prophylls are basal on the lower length which rises from a chamber. This length arose by growth within the massive tissue-column which was defined when outer bark was ruptured inwardly and caused the chamber to be formed and fixed its depth and breadth. The upper length of upright shoot with compact, crowning bud was formed entirely by the growing-point which all the prophylls hid until the apex of the leader-bud had ceased to be at rest. The organs of a subsidiary bud (S) are all within the chamber. Some of the prophyll-bases show lateral buds within them (P) : some of their free tips overarch the resting growing-point. Tracheidal strands are forming beneath the subsidiary bud. A tube of formed and forming wood is in the upright shoot and is extended inwards through tissues of the ray-mouth until it joins the outer wood which formed within the trunk.

While tubes of tracheides link the shoots to outer sheets of trunk-wood, some changes are in progress, deep in the living bark. The tissue round tracheidal links is altered, here and there, to flat or ovoid meristems in bounded parenchyma (Pl. 42, fig. 47, A, B, C). The meristems are few at first, but, later, fairly numerous, so that new fields become defined beneath the older ones. It may suffice to notice here that new fields organize and are, in time, the sources of many flowering shoots. A second change is evident when many little strands of latex-tubes are forming around tracheidal links and also at quite distant points within the broad ray-mouths (Pl. 42, fig. 47). It must suffice to underline that, when this change is ended, the shoots are vasculated and flowering is begun, and to refer to several steps which always are involved. A tracheidal tube which has been formed below a lengthening shoot is almost fully clothed, in time, in radial sheets of phloem. The phloem is linked to narrow strands of little latex-tubes which organize beyond its fringe and come to be connected. When many strands have been matured, they form a phloem-mantle which, duly, is extended along the length of tube except beside a new

field and in the upright shoot. The mantle is developed, first, close to the functional cambium and is connected there to bast across the ray-mouth's margins. Cross-sections at this level show how any link matures (Pl. 42, fig. 48), with tortuous strands of tracheides inside a narrow cambium which is, in turn, invested in radial sheets of phloem. They also show how mantle-strands (PM) compose an elaborate plexus and join investing sheets of bast (PH-PH) through many marginal strands. When similar connections are made at higher levels, the basal lengths of young shoots are rapidly extended, and tips of upraised prophylls are suberized and falling (Pl. 36, fig. 32, P-DB). The tender middle lengths of shoot bear mainly leafy buds (VB); and large flower-buds are forming along the distal lengths (FB). The growth of shoots does not prevent new meristem-formation (M-M), so that, when shoots have withered, they may all be replaced.

10. *The separation of prophylls and the freeing of lateral buds : the ligules.*

It should be shown how lateral buds are finally exposed and proved that prophylls are alive until their tips are freed and ligules over lateral buds are broken or destroyed. I should, however, first recall that young prophylls are curved so that thin sections through a compound bud do not expose their lengths (Pl. 37, fig. 35). Their curvatures are lessened when some have freed their tips and they resemble scale-leaves around an opening bud (Pl. 31, figs. 7, 8). The lateral buds are still within their tender, narrow bases when many are uplifted on basal lengths of shoot (Pl. 42, fig. 47). Before these lengths have been defined by deep tears in the bark, the overarching prophylls diverge and partly straighten. Cross-sections, at the latter stage, through outer bark and cork, should show some lateral buds enclosed in basal lengths of prophylls and tips of inner prophylls which have been fully freed (Pl. 38, fig. 39). This figure does not sample the tissues of the column round which the prophylls had remained in close, ascending group. The figure shows a meristem (M) and several groups of stone-cells (S-S), and—near the centre—broad cell-walls which, doubtless, mark a cleavage-line between the bark and prophylls. High on the left, a prophyll-tip is almost fully freed : some of the prophylls under it are cut in basal lengths (P-P). Since prophylls curve in upward course, these lengths appear lenticular. The lateral buds in three of them are towards their narrow bases. The lowest bud is traversed in almost median plane so that its upraised margin and growing-point are shown. Comparison will make it plain that, even at this stage, the lateral buds are resting or have retarded growth (viz. Pl. 38, fig. 38). The adaxial flaps or ligules upon the prophyll-bases (L-L) are outlined at this stage in growth by sheets of broad cell-wall which are extending downwards until they reach the buds at marginal points which vary according to their courses and to the levels of the buds within the basal lengths.

The prophylls do not separate along opposing faces until the column has been freed from all surrounding tissue and has been broadened and become the basal length of shoot (Pl. 42, fig. 47). The outer tissues of this length mature as sclerenchyma while internodes are lengthening between the prophyll-bases (Pl. 39, fig. 42, A, B). The lateral buds are sunken, as broadening proceeds, and free their growing-points and rims in very tiny chambers (Pl. 39, fig. 42, A, centre). The upper lengths of prophylls are always freed directly and look like little awl-shaped scales when they have been enlarged and all their tissues are transformed to thick-walled sclerenchyma (Pl. 39, fig. 42, A, right). Their middle lengths are sunken, and often lose their outlines : their deep-placed lower lengths are always well-defined as lenticles of tissue with buds at inner ends (Pl. 39, fig. 42, A, centre). Exposure of the buds begins when inward splits develop where upper faces of the scales are merged in sclerenchyma. A split may pass above a bud and reach its inner face (Pl. 39, fig. 42, B) or fail to tear

the chamber-wall, if ligule is displaced to right or left, and is not shown in sections in almost median planes (Pl. 37, fig. 36, A). A chamber-ceiling fractures and may disintegrate but often leaves its remnants above the growing-point (Pl. 39, fig. 42, B). When ligules have been sectioned along their greater lengths, they may be seen to cover the growing-points and rims (Pl. 37, fig. 36, B). The middle lengths of prophylls which have remained united are greatly widened during growth within the broadening nodes. Thin abscission-layers are organized across their outer zones when inward splits are deepened towards buds in prophyll-bases (Pl. 37, fig. 36, A). The sclerotic scales become detached from broad abscission-tissue (Pl. 39, fig. 42, B); and when this tissue also falls, the stumps of middle lengths are sealed in sclerenchyma, whilst lateral buds enlarge (Pl. 37, fig. 36, B). Thus, basal lengths of heightening shoots are clothed in sclerenchyma; and lateral buds are 'axial' to scales or stumps of scales when chamber-ceilings have been torn and growing-points exposed (Pl. 36, fig. 32, basal length DB). The lateral buds are dormant while flowering is in course and are unchanged when flowering shoots have left broad, ragged stumps. I do not think they ever grow to minor flowering shoots or are developed further than minor buds with rims.

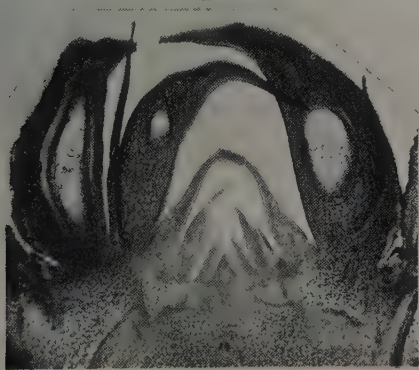
11. *The isolation of arrested buds.*

There is no certainty that flowering shoots will spring from any field even though it has a number of compound buds within it. While some buds fail completely when they have been enlarged and freed their total prophylls in wide unopened chambers, the growth of neighbours may be stopped at some late stage in growth (Pl. 40, fig. 43 and Pl. 41, fig. 45). These figures show a broadened field in nearby transverse sections and illustrate especially how buds may be arrested. The field contains a leader bud (L) and two subordinates (S.S) and, at the least, three compound buds in marginal positions (A, B, C). The prophylls of the central group are freed and suberized (solid black): the unchanged bodies are composed of small-celled parenchyma (white). The subsidiary buds are not traversed in fig. 45 which shows a margin of the leader-bud (L) and parts of outer prophylls. A complex tissue-system has formed beneath the group which lacks all signs of tracheides below the massive bodies or in the body margins beneath the crinkled prophylls. Comparison of various fields with large arrested buds has shown that the system was formed by a cambium which was in deep-placed tissue beneath the major buds and was extended, right and left, at ever-lessening depth until it joined the phellogen beneath the surface-cork (solid black). The cambium's outer products were layers of parenchyma with sheets and nests of stone-cells throughout their greater depth (solid black) and with a narrow sheet of cork as outer bounding-layer (grey). The cambium's inner products were layers of parenchyma, much deeper than the outer layers, but equal them in number. The depths of inner layers are shown by fine tracheidal strands which have not been connected to form continuous wood (grey). Although bud A was organized with prophylls still united, some prophyll-tips are suberized for more than half their length (Pl. 40, fig. 43, left). Between it and the major group are small arrested meristems in little chambers which are lined by narrow sheets of cork. Bud B is partly covered by thin continuous cork: its narrow, outer prophylls are fully suberized (solid black). The middle prophylls of bud C are partly suberized (fig. 45, right); and such small buds as D and E appear to be unaltered (fig. 45).

Some other fields examined have shown that many buds had been invested fully by narrow sheets of cork and that although these fields contained both major buds and meristems, there were no signs of forming shoots throughout their lengths and breadths. I have been told by Holttum of how he has observed that isolated buds and bark and covering sheets of cork are shed like pills from flowering trunks, and have myself confirmed that cork beneath arrested buds



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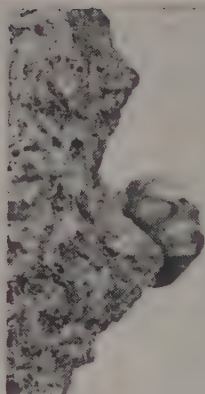


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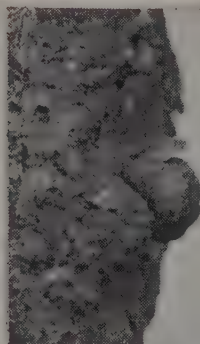
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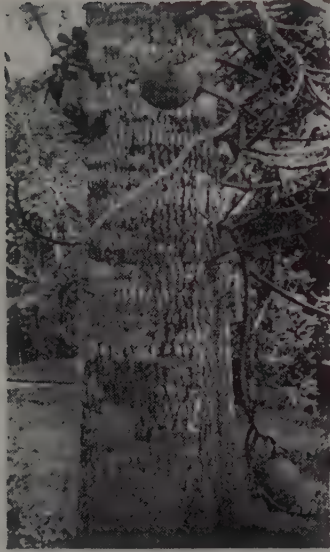


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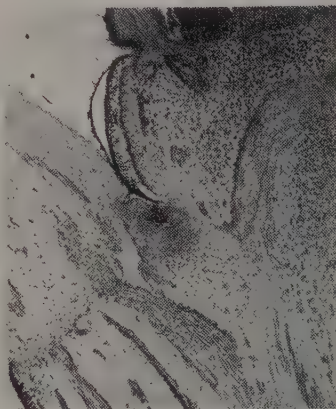
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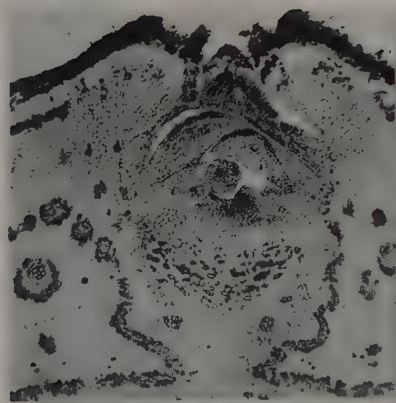
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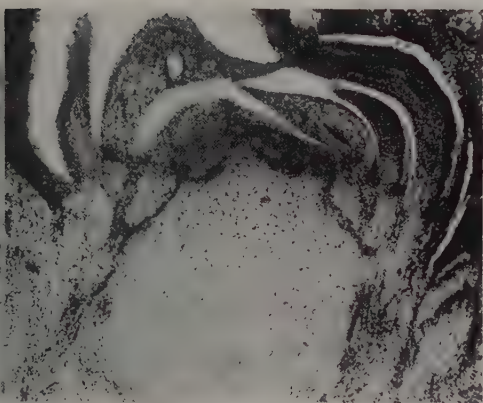
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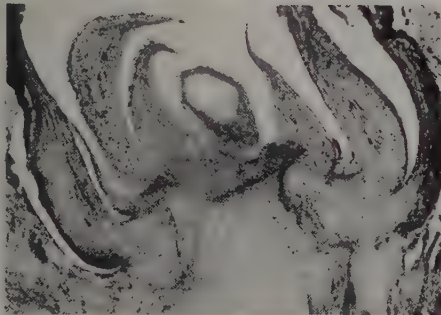
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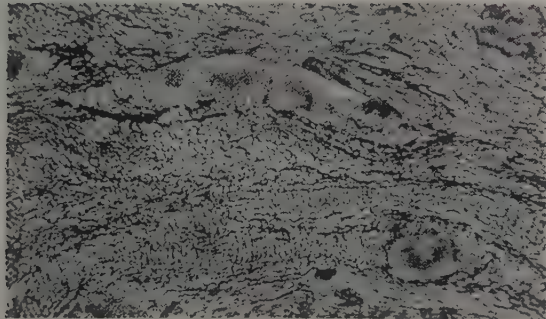
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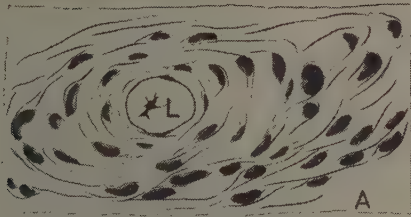


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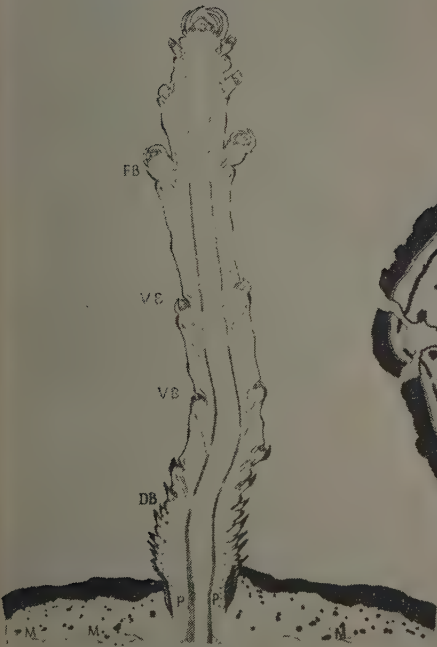
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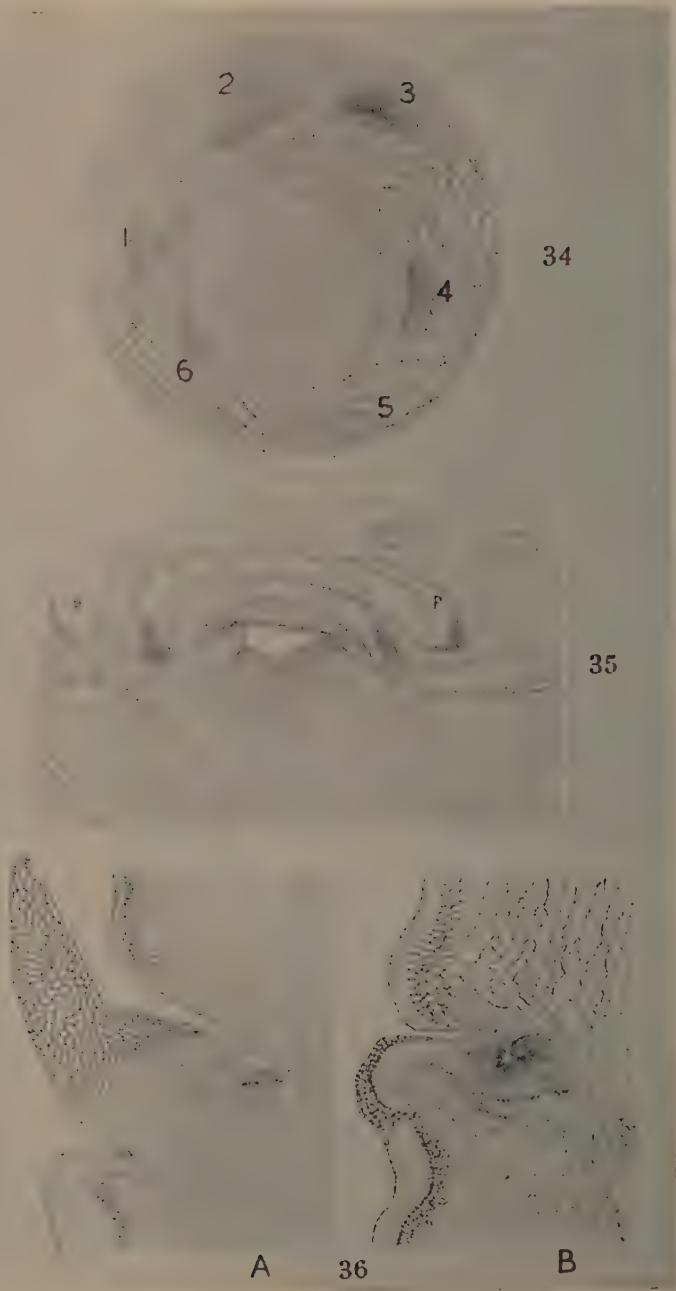


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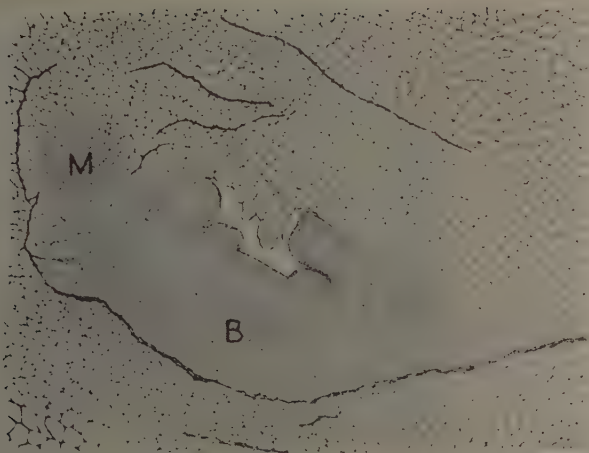


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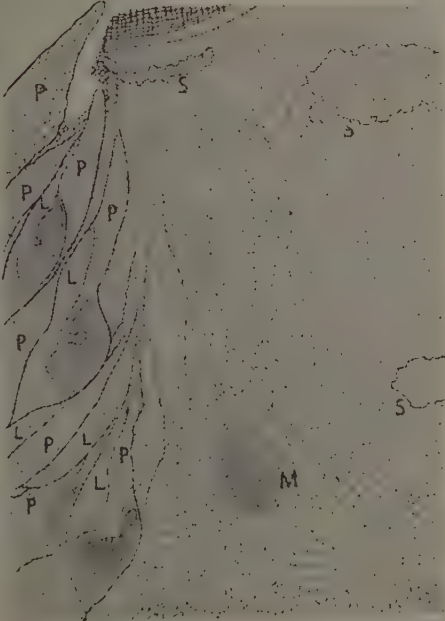
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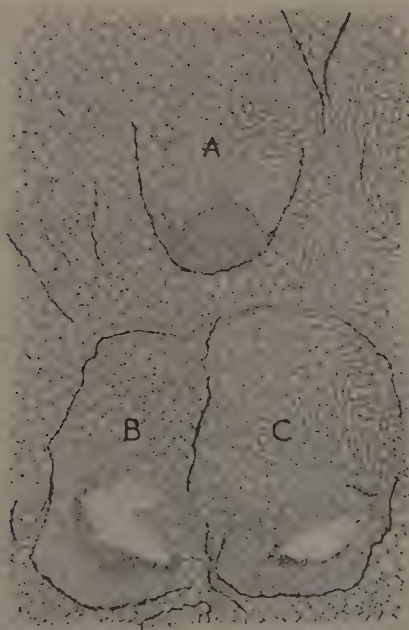


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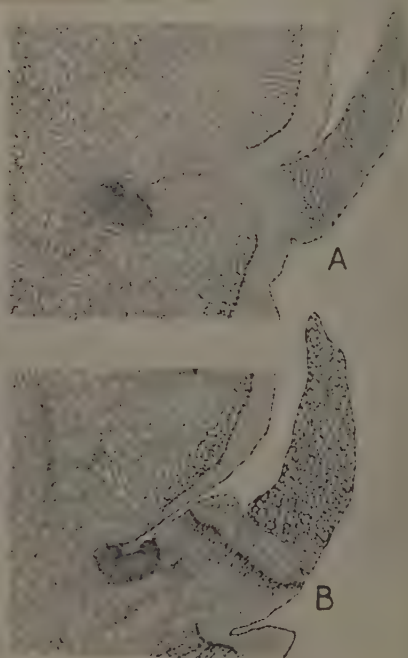
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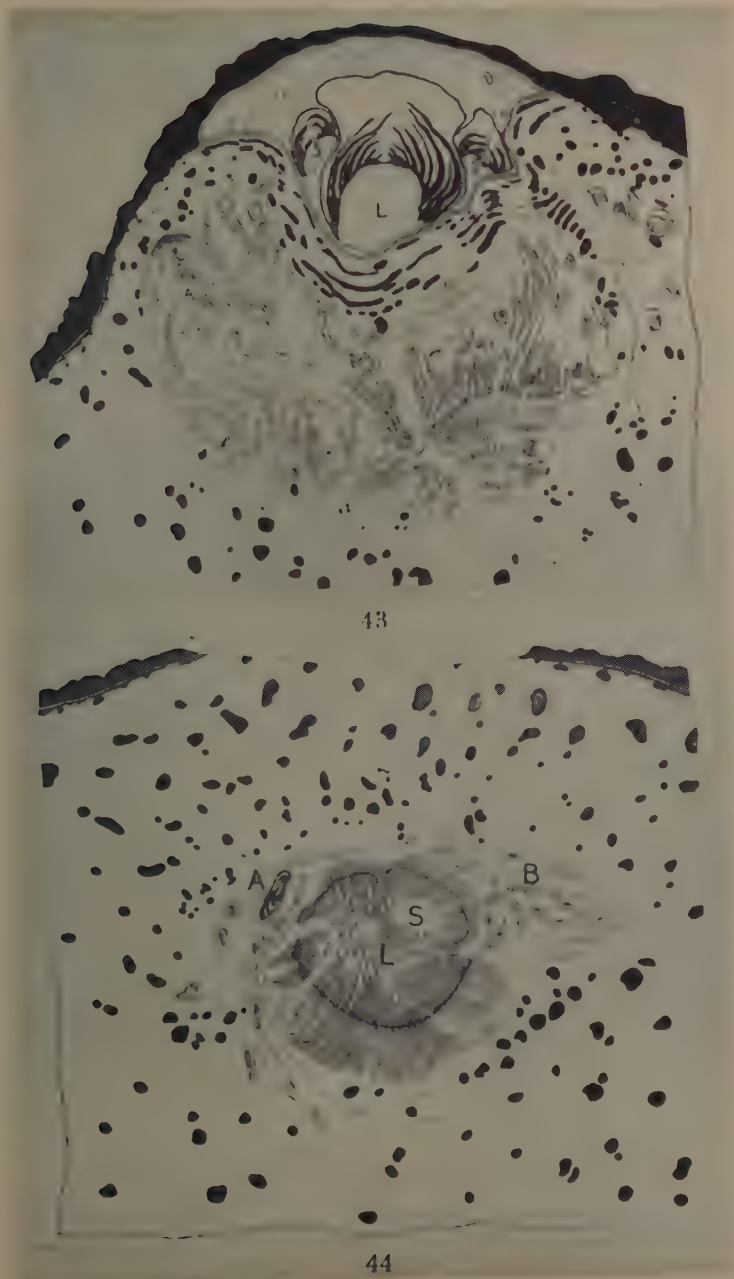


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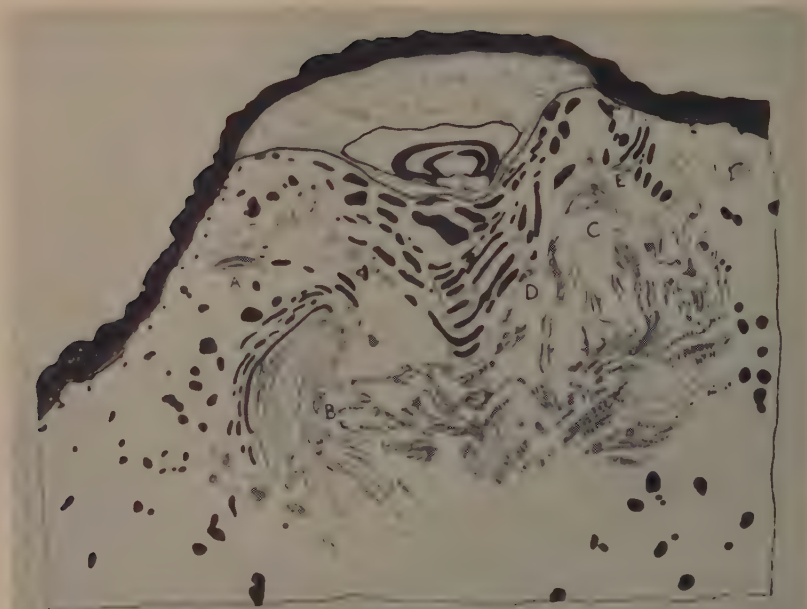


42

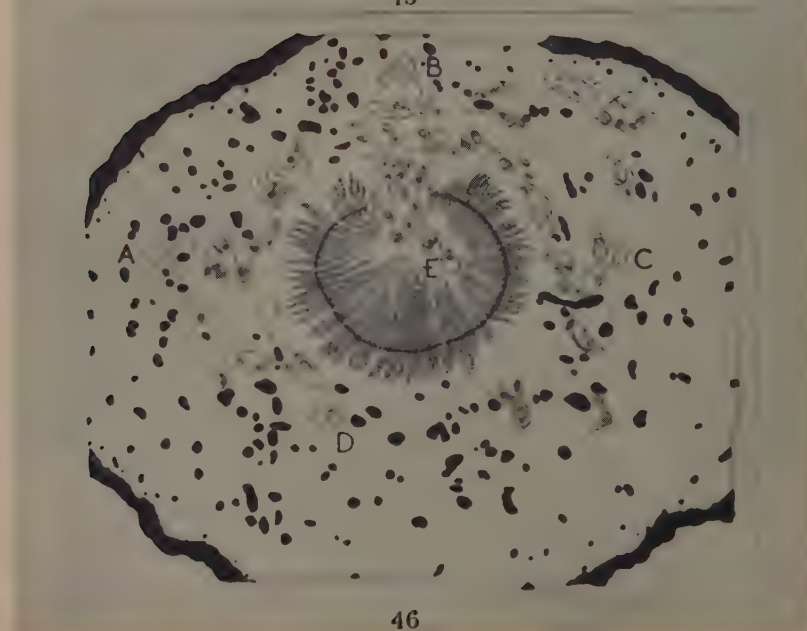
Couroupita guianensis Aubl.



Couroupita guianensis Aubl.



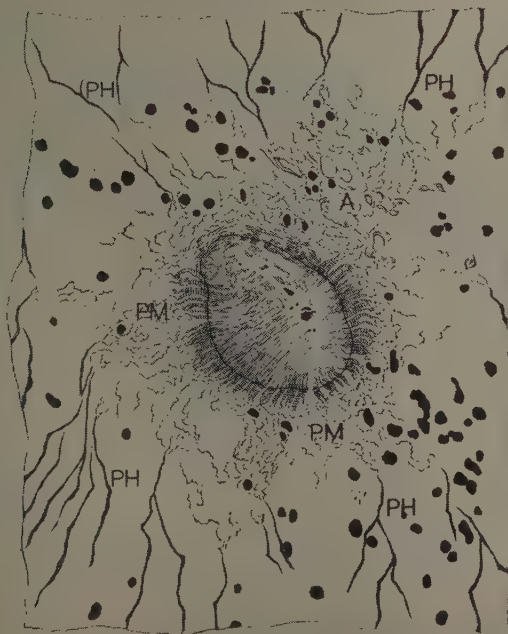
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Couroupita guianensis Aubl,

persists and is undamaged when pill-like masses have been shed and left deep surface-pits. One cannot then assess the buds which living bark contains by flowering shoots which are exposed along the broadened trunks but may conclude, with reason, that they are very numerous, and that arrest is common in many larger fields.

12. *The vasculature of flowering shoots : and new fields.*

In contrast, groups of flowering shoots are formed from many fields and are developed, commonly, with near equality. Their vascular links are broadened before they start to flower; and meristems are organized in new and deeper planes around the links and, often, within their tender cores (Pl. 41, fig. 46). This figure shows a broadened link as crossed in middle length, with independent meristems in little bounded fields within surrounding tissue which A-D defines. Some independent meristems are in the narrow core (E) : a few are in a stelar 'gap' of thin-walled parenchyma. The links of neighbouring flowering shoots which have been formed together converge and are concurrent in lower middle lengths (Pl. 40, fig. 44, L, S). There may be many meristems beneath their junction-levels (B); and compound buds are common outside the sheets of phloem (A). Such buds as are reduced to plans in fig. 31 (Pl. 36) are often round the inmost and broadest length of link. Strong flowering shoots are formed from them despite their deep positions. Since dual or triple growing-points are common in these buds and any one may grow to dominance and thrust the rest aside, it might be thought that flowering shoots have sometimes lower branches, with bases in the broadened pits from which the strong shoots rise (viz. Pl. 36, fig. 32).

13. *Progressive flowering : and the loss of branches.*

It has been noted that a young tree sheds its lowest, drooping branches before some flowering shoots are first observed extending from its bole (Pl. 31, fig. 6). When Holttum made this photograph, he had good cause to think the tree was little more than fourteen years of age, and called to mind its recent loss of several lower branches and how small scaly 'buds' appeared through fractures in the cork (Pl. 31, figs. 7, 8). There are two obvious branch-scars upon the upper bole, resembling massive lenticels with broadened, upraised margins. The smallest shoots, which will be seen in mainly profile-views, project from little domes : a lengthening shoot is evident upon the middle bole. These and less obvious little shoots were harbingers of many which, later, drew attention as grouped or scattered widely between the levels three feet and nine feet from the ground. The ends of leafy branches at slightly higher levels are drooping, to the left, around the upper bole.

A photograph by Asprey (Pl. 31, fig. 9) shows well how flowering shoots are branched and twisted when they lengthen and straggle round the bole. They lengthen intermittently by major increments : the flowers are always clustered around their apices. Expanded and expanding flowers are shown in fig. 10 (Pl. 31) and serve to indicate, at least, the fleshy perianth, both large and tiny stamens in independent groups, and how the little stamens invest the truncate style (2, 3). When fruits are forming locally near tips of lengthened shoots, the pedicels of flowers which fail persist as cork-sealed stumps (Pl. 31, fig. 9, and Pl. 32, fig. 11). Maturing fruits do not prevent still further growth in length; but as this growth continues, new flowers are rather scarce : and when the branch-tips reach the ground, they may be mainly foliar. The full-grown fruits are very large and often perfect spheres (Pl. 32, fig. 12) : they seldom fall directly; but when they have been shed, the pericarps are rotted before the seeds are freed. Old flowering shoots are flexible despite their woody state; unlike the leafy branches which leave their cork-clad scars, they always fracture near the base and leave broad, jagged stumps.

When many flowering shoots have formed upon the upright bole, still further drooping branches are shed at higher levels (Pl. 32, fig. 13, photographed by Holttum). A lengthy forking branch, to right, droops steeply as it falls : a basal length of lower branch had barred its downward progress. Two recent, narrow branch-scars are fairly evident : one is quite near the basal length which stopped the falling branch : the other is three-quarter inch above the figure-number. There is no strict succession in casting-off of branches so that a few are still to fall when new-formed shoots appear above some recent branch-scars or at new points between them (Pl. 32, fig. 14, photographed by Holttum). The domes which carried flowering shoots at levels on the bole have meantime grown to massive burrs, if compound buds are in them. These buds yield many flowering shoots in groups upon the burrs : and thus, as flowering levels rise, the bole may flower repeatedly. A lower length of middle-trunk which has been flowering often has, in its turn, a great display of ugly, massive burrs, with straggling, thickened flowering shoots or stumps upon their tips or grouped in various numbers upon their roughened sides (Pl. 33, fig. 15, photographed by Holttum). These burrs are also sources of further flowering shoots which may be formed or forming through many years of growth.

14. *Flowering from the stumps.*

The ragged stumps of flowering shoots arouse peculiar interest not only since new shoots arise within their living bark (Pl. 35, fig. 26) but also by the absence of independent meristems. The dead and living tissues are fully isolated (Pl. 43, fig. 49). The dead soft tissues dry and form a sunken, stony rim. The fractured wood is shrunken along its outer length. The cambium is active before the wood has shrunk in forming broadening inner layers of large-celled parenchyma containing nests and parallel sheets of stony sclerenchyma (Pl. 43, fig. 49, D, solid black). The inmost layer, at least, matures as thin continuous cork which isolates completely the mass of shrunken wood (Pl. 43, fig. 49, grey). The cambium (C) remains in place beneath undamaged bast (PH) and plays an active later part in adding tissue to it. When rim and wood have shrunken, large compound buds are formed in many of the ray-mouths, not far beneath the fracture (Pl. 43, fig. 49, A, B). The ray-mouths are like minor fields at many points on trunks in that no other tissue supplies new flowering shoots. There is a level on a stump where wood remains unshrunken and has the narrow cambium between it and the bast (Pl. 43, fig. 50). This figure shows the common state at many lower levels, with single, massive compound buds in much-distorted ray-mouths (A and C), or, sometimes, with a pair of buds when mouths are very broad (B and C). Most of these buds form flowering shoots like those upon a trunk ; their vascular links are organized when they have been composed and furnished with tracheidal strands which join the woody core (Pl. 43, fig. 50).

15. *Minor points of evidence.*

Some minor points of evidence require a few comments although they merely underline the need of further study.

When flowering shoots have grown long, and increments are few, the scale-leaves of the apical buds subtend two buds in row. The upper buds develop as small imperfect flowers with only narrow, central pits in place of ovaries (Pl. 35, fig. 28, centre). A lower bud remains at rest and is extremely small (Pl. 35, fig. 28, left on pedicel) until the neighbouring flower-head is shrunken and excised above a narrow absciss-layer which seals the pedicel (Pl. 35, fig. 27). The lower bud enlarges then and forms a normal flower or one which is arrested when stamens organize. The pedicel of an imperfect flower is quickly clothed in cork before its hairy skin has shrunk or hair-tips have been broken. A second, basal absciss-layer is formed across the pedicel ; and when the greater length is

shed, this layer becomes a phellogen. Its total inner products are radial rows of cells, a few of which are added to outer living bark. Small single buds are organized within this compound tissue (Pl. 35, fig. 29) : some are arrested, others freed as normal single flowers.

When increments of lengthy shoots bear few and scattered flowers, and hairy leaves are closely grouped beneath their apical buds, the pedicels are fractured, and ruptured tissue hardens ; but stumps persist and shrivel, and have no corky layers (Pl. 35, fig. 30). Some upper lateral buds produce peculiar little spur-shoots which, often, are entirely clothed in white aerated cork and thrust aside the apical buds and all the hairy leaves. When spur-shoots add new current lengths, the cork disintegrates, and displaced apices remain at rest, or grow extremely slowly.

As trees grow old and upper trunks become chief seats of flowering, the boles and lower trunks may bear ephemeral leafy branches which spring from compound buds in stumps of early flowering shoots. These branches lengthen quickly and are most prone to wilt as soon as they extend. Unlike the major branches, they lack abscission-layers. They fracture near their bases and leave persistent stumps.

CONCLUSION.

It has been found that flowering shoots upon a sturdy limb are not developed till the last of all the drooping branches fall and active flowering is in course along the upper trunk. The leafy twigs within the crown grow like the drooping branches except that they are rather short and, commonly, sympodial. Their lateral buds are single ; and those on middle lengths form thin side-branches with close groups of leaves below the apical buds. The branches ending in a group of twigs are sloping or erect and are side-branches of a permanent limb and mainly near its tip. They grow like suckers and become the minor permanent limbs which give the crown a framework in early middle life. I have examined several lengths but have not found a trace of meristems or forming buds within their living bark. There can be then but little doubt that flowering is restricted to trunks and lower limbs, and that all flowering shoots are formed from compound buds in bark.

I think, however, that the flowering course could alter in this tree, if buds in all the ray-mouths remained in independence and were developed equally and led to flowering shoots. These shoots would have no lateral buds or prophylls on their bases : in this respect, they would be like the many flowering shoots which spring from single deep-placed buds in bark of Carob Trees (4, 6). In many ways, the course would be like that in *Theobroma* if superficial buds survived on trunks and major branches and furnished many flowering shoots, at ever-rising levels, and bud-formation in the bark became a late event. Whatever factors fix the age at which a tree first flowers might cause the twigs of young trees to form simple spikes some time before the flowering shoots appear upon the bole, and might keep crowns in constant flower, as in related trees.

The behaviour of some allied trees suggests a great plasticity which still awaits enquiry through young and well-grown trees. *Gustavia superba* flowers first upon its crown and, like *G. angustifolia* and *G. speciosa*, flowers later on its trunk. *G. pulchra* is known to flower along the lower bole, whilst flowers are limited to leafy twigs in *G. superba*. It is confirmed that *Lecythis grandiflora*, *L. zaboucaya* and *Couroupita surinamensis* have only branch-borne flowers, that trunk-borne flowers and terminal flowers are formed through many seasons by *C. odoratissima*, and that *C. peruviana* only flowers on thin maturing twigs, True cauliflory or ramiflory are shown by *Grias*, *Couratari*, *Barringtonia*, *Napoleona*, *Craterantos*, *Lecythopsis* and *Asteranthos* which, like those named above, are Lecythidean plants. They, too, appear to call for new and rather

special study, freed from the preconceptions that plants must reproduce through surface-buds, and that ancestral forms must all have blossomed distally throughout their lengthy lives.

The writer wishes to express his thanks to his own University for aid towards the costs of illustration.

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DESCRIPTION OF PLATES 30-43.

The description of the plates is given in the text of the paper.

OBITUARIES

Sir **Sidney Frederic Harmer**, K.B.E., Sc.D., F.R.S., died in Cambridge, on 22 October 1950 at the age of 88. He was the second son of Frederic W. Harmer, merchant and manufacturer, of Norwich, who took a leading part in the affairs of his native city, and was an amateur geologist of distinction. S. F. Harmer inherited his father's high principles and public spirit, and his interest in natural history.

He went to Amersham Hall School, and thence as a Scholar to University College, London. He obtained the London B.Sc. degree at the age of 18, and then went up to King's College, Cambridge, where he had a distinguished career as Exhibitioner, Scholar and Fellow. He was placed in the First Class in both parts of the Natural Sciences Tripos.

As tutor of King's and University lecturer in Zoology he taught advanced students for 22 years. Tributes from his former pupils, some now eminent themselves, tell of the clarity of his teaching which gave 'a balanced and judicial summary of existing knowledge' of the matter in hand; of the high standards of 'industry, patience and accuracy in observation, clarity and precision in record' which he inculcated and himself maintained; and of the affection he inspired throughout his life by his gentleness, courtesy and kindness.

In 1892 he became Superintendent of the University Museum of Zoology where he re-catalogued the collections with his characteristic care and improved them by the judicious acquisition of many specimens. In 1908 he left Cambridge on his appointment as Keeper of the Department of Zoology in the British Museum (Nat. Hist.), of which he became Director in 1919. He retired in 1927.

During the Cambridge years his chief researches were on the embryology, anatomy and taxonomy of the Polyzoa, and on *Cephalodiscus*. In the course of this work he made two discoveries of general zoological importance. Firstly he recognized and demonstrated the Protochordate affinities of *Cephalodiscus*. Secondly he discovered that the embryos of the Cyclostomatous Polyzoa undergo a process of fission by which one embryo produces numerous larvae. The other papers are of more specialized interest. Each is a model of lucidity and accuracy, illustrated with his own beautiful drawings; each made a solid advance in thought and knowledge of the problem handled; and they have not been superseded. His revisions of the British species of *Crisia* and *Tubulipora* are (like his later paper on Cellularine Polyzoa in the Linnean Journal) good

examples of his success in recognizing, analysing and applying new taxonomic criteria. His paper 'On the Morphology of the Cheilostomata' is characteristic*. In it he studied the frontal wall, operculum and compensation sac of the Cheilostomata Ascophora. He enumerated succinctly the type of structure he had recognized, commented on the bearing of his results on the classification and on the accordance of his conclusions with the palaeontological evidence, and yet refrained from any precipitate attempt to reclassify the group. It is gradually being recognized that the characters so unassumingly indicated may be of fundamental importance in the reclassification that will have to be made when our knowledge is ripe.

He was joint editor with his Cambridge contemporary, Sir Arthur Shipley, of the Cambridge Natural History. His own contributions on the Hemichordata and the Polyzoa are masterly, and the latter is still the best introduction to the subject.

The Cambridge period saw the beginning of his work on the Polyzoa of the Siboga Expedition and of his interest in whales, which were to form the two main threads of his life's work.

His Siboga work proceeded steadily during his London years and after his retirement as long as his health allowed. The first three volumes were published in 1915, 1926 and 1934, and the descriptions and drawings for the last and largest volume were completed by 1941. Engraving of the plates had started when war intervened, and to Sir Sidney's great anxiety many of the drawings were with printers in Holland throughout the German occupation. Fortunately they remained intact and printing has now been resumed. These reports give not only a full and accurate account of an extremely interesting and almost unknown Polyzoan fauna, but also important revisions of the genera concerned. They are illustrated by numerous exquisite drawings and contain information useful to every worker on the Polyzoa.

His years at the British Museum brought a development of his interest in whales. He published an impressive number of papers of his usual high standard, and his indexes and note-books give evidence of an immense volume of work that did not reach the point of publication. His greatest contribution here was, however, his initiation of the scheme for the recording of whales stranded on our coasts. This scheme has brought a continuing flow of material and information to the Museum. Moreover, through his contacts with people in the whaling industry he was able to acquire for the Museum many skeletons of larger whales which are difficult to obtain and transport. In these ways he enhanced the value of the British Museum collection of Cetacea so that it must now be one of the best, if not the best, in the world.

He further helped to advance the study of marine life in general, and particularly of whales, by his keen and effective interest in the work of the Discovery Committee, of which he was vice-chairman for 18 years. He was also chairman of the Discovery Scientific Sub-Committee from its inception in 1927 until failing health compelled him to retire from active participation in the Committee's work in December 1942. Before the formation of the Discovery Committee in 1924 he was a member of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands to whose report, published by H.M. Stationery Office in April 1920, he contributed a valuable appendix 'The Present Position of the Southern Whaling Industry'. The later researches on whales conducted by the Discovery Committee, which were eventually to lead to effective international control of Antarctic whaling, were largely carried out on the lines he suggested in this important article.

His wide interests in museum work were shown in many ways, for example, by his initiation of experiments at the British Museum on the fading and decay of museum specimens, and by his long connexion with the Museums Association,

* Quart. J. Micr. Sci., 46, 1901, 263-350,

He was President of the Association at its meeting at Norwich in 1904 and was made an honorary member in 1922. He also maintained his early interest in the Norfolk and Norwich Naturalists' Society of which he was President in 1901.

Harmer's industry was prodigious. To every matter, whether it was his own duties and researches or the help that he so readily gave to others, he brought the same conscientious thoroughness, the same 'minute and sedulous care' (to quote the obituary notice in the 'Times'). He has left a great volume of files, indexes and note-books filled, during his taxonomic work, with accurate information, methodically arranged and neatly written (or in the latest volumes type-written) all with his own hand. These, together with his exceptionally fine library of works on Polyzoa and Whales, he gave to the British Museum (Nat. Hist.) to the great advantage of students of these groups.

Like many other zoologists of his generation, he worked as a young man at the Stazione Zoologica at Naples, and found there the opportunity and stimulus which the Plymouth Laboratory has brought to later generations. He, too, worked at Plymouth, and for many years took an active interest in the affairs of the Marine Biological Association and its laboratories.

His familiarity with the Italian language dated from his youth, and evidently owed much to his stay at Naples. He knew enough of several other languages for his scientific reading, including Swedish which he learned especially that he might read the works of F. A. Smitt. He travelled extensively, was fond of music and was a competent pianist. He was a keen cyclist from the early days of the high-bicycle until quite late in life, and he was always an enthusiastic and very knowledgeable gardener. During the first world war he spent many nights on duty as a special constable, chiefly on Charing Cross Bridge; but he never let this interfere with his work at the Museum the next day.

He was a Fellow of the Linnean Society for 31 years, served on the Council, 1921-24 and 1927-32, was a Vice-President, 1931-32, and President from 1927-31. In 1934 he received the Linnean Medal. He was innately punctilious, and many Fellows will remember the blend of affability and formality with which he performed the little ceremony of the admission of Fellows. Two of his Presidential Addresses to this Society, on 'The History of Whaling', and on 'Southern Whaling' (for years 1928 and 1930), constitute a history of whaling which has been described as one of the most useful books of its kind. He devoted his other two Addresses (for the years 1929 and 1931) to the Polyzoa. In them he gave a useful account of the group and a survey of the more significant contents of some recent papers on the living animals, together with observations and comments of his own.

He was elected a Fellow of the Royal Society in 1898, served on the Council and was a Vice-President. Among other honours, he was made a Foreign Member of the Norwegian and Swedish Academies, and an Honorary Member of the Boston Society of Natural History and of the Société Zoologique de France. He was knighted in 1920.

In 1891 he married Laura Russell Howell, his devoted partner for nearly 60 years of happy married life. Those, and they were many, who visited them recall their hospitable home with affection and gratitude. They had two sons and two daughters.

His devotion to Cambridge, and particularly to King's, was deep and lasting. It was a great happiness to him that in 1922 he was made an Honorary Fellow of the College, and that on his retirement to Melbourn, near Cambridge, he was able to be once more in close touch with his College, to dine in Hall, and above all to attend the Chapel services.

I should like to end this notice by acknowledging the ready help of all those to whom I appealed for information about Sir Sidney, particularly mentioning Lady Harmer, whose assistance included a loan of letters, and Mr. Frederic Harmer, C.M.G., who lent me the script of his own account of his father.

ANNA B. HASTINGS.

James Insch (1877–1951). The late James Insch belonged to that large body of naturalists who, while following a business career, have in Britain done so much in the past, directly and indirectly, to foster the study of natural history.

Born in Morayshire in Scotland in 1877, he left school at the age of 15 to work as gardener on the Duke of Gordon's estate at Gordon Castle. While working there and on other estates in Scotland, in Cumberland and in Oxfordshire, he developed an extraordinary interest in botany, especially in its practical applications, and he finally accepted an appointment in the Indian tea industry at the age of 25. He was appointed an assistant on the Ellenbarrie tea estate in the Western Dooars, in the agency of Messrs. Duncan Brothers and Co. of Calcutta, with which firm and its London House he continued in one capacity or another to the end of his life.

I first met James Insch when he was at Ellenbarrie and was struck with his interest in the problems of tea cultivation, which involve questions of plant physiology that hardly occur with any other cultivated crop. The production of the largest number of young leaf shoots possible on each tea plant for the longest period every year and the maintenance of this production for as many years as possible offer problems which fascinated young Insch and he devoted a very keen mind to the solution of the commercial problems which they offer, while serving on and managing a number of other tea estates in the Dooars and Assam.

He did not publish the conclusions that he reached, but he quickly became regarded as an exceptionally successful planter, being appointed visiting agent for Messrs. Duncan Brothers and Co. to many of their tea estates in the Dooars, Assam, Cachar, Sylhet, Darjeeling and the Darjeeling Terai. He was made a partner in the firm to which he was attached in 1921 and remained in Calcutta as senior resident Director till 1932, being the recognized authority on all questions connected with tea cultivation and manufacture.

He left India for England in 1933, becoming a partner in the London firm of Messrs. Walter Duncan and Co., and remained in their London office till 1938 when he retired from active office work. This was not the end of his activities in connection with tea growing, for up to the time of his death he continued to act as adviser to the Duncan group of tea estates, reviewing all tea garden inspection reports with an unrivalled knowledge of tea gardens and of the practical problems connected with them—a knowledge which was continually being enlarged until the date of his death.

Mr. Insch, during the many years of his connection with tea, built up what was perhaps the best private library of works on tea culture in all parts of the world, which he has left to the Linnean Society (of which he was elected a Fellow in 1940), himself providing the funds for suitably binding the works contained in it. Despite his eminence as an authority on tea, Mr. Insch retained a very modest bearing, and it was a refreshment to come into contact with him in his later years and to see the readiness with which he received new ideas on what, with him, had been a life study.

HAROLD H. MANN.

Colonel **Austin Edward Armitage**, elected a Fellow in 1948, died in hospital at Victoria, Seychelles, in April 1951.

After serving in the army in India, Colonel Armitage retired to Seychelles, where he and his wife had bought an estate. He had many interests including the study of tropical fish, of which he had a close and intimate knowledge. Wild life preservation also was a subject of keen interest, with constant vigilance for the preservation of the colony's fauna. This interest was of great practical value, particularly in an area such as the Seychelles Archipelago where, owing to deforestation and other causes, many endemic species were in danger of extinction.

He was prominent in public life and, in addition to numerous other duties, he was a member of the Governor's Executive Council. His advice and counsel was at all times both sound and constructive, and ranged over a wide area. As a proprietary planter, he took particular interest in the welfare of his labourers, who lived in model surroundings in keeping with the orderliness of Bel Ombre Estate. He was a pioneer in this respect and the good example set was a source of inspiration to others.

His death at a comparatively early age is a very great loss to the Colony and to the advancement of natural history in that part of the Indian Ocean; he will be sadly missed by all who knew him. He was buried at sea off the coast of Mahé.

J. N. MILSUM.

Professor **Frederick Tom Brooks**, C.B.E., M.A., LL.D., F.R.S. By the death of Professor Brooks which took place with unexpected suddenness on the evening of the 11th of March, not only the world of biological science but many institutions, official and otherwise, have lost a great leader and investigator whose sincerity and forthrightness were acknowledged by all who came in contact with him.

The youngest of a family of three girls and two boys, Frederick Tom Brooks was born at Wells, Somerset, on 17 December 1882, and was educated at Sexey's School, Bruton, where he first developed that love of field botany which he never forsook. Destined for the teaching profession from the beginning, he left school at the comparatively early age of 15 to enter a Training College at Bristol where the rigorous methods then in force and the ordeal of facing large classes developed his inherent gifts of lucid exposition and courage which were to play so great a part in the future. In all his examinations at the Training College and subsequently at the University Brooks gained 1st classes.

In 1902 Brooks was awarded an Exhibition at Emmanuel College, Cambridge, and proceeded to read for the Natural Sciences Tripos, making botany, which had so attracted him at school, his main subject. It was not long before he came under the watchful eye of his professor, Marshall Ward, whose chief interest at that time was the investigation of plant diseases, especially those caused by the rust fungi. After gaining 1st Class honours in both parts of the Tripos in 1905, Brooks was appointed junior demonstrator in Botany for the maximum period of five years. In September the following year, Marshall Ward died after a long illness and Brooks was left to carry on the work in mycology at the early age of 24 without the help of the one person who had such faith in him; a faith fully justified for the next 40 years.

Besides his demonstratorship Brooks had also been awarded the Frank Smart Studentship in Botany which necessitated changing Colleges and he took up residence in St. Michael's Court, Gonville and Caius College, where the present writer as an undergraduate first met him to go over a youthful essay on some mycological subject.

In 1907 Brooks married Emily Broderick and together they set up house in Mawson Road but later migrated to nearby Tenison Avenue. There were no children of the marriage. Towards the end of 1913 Brooks was seconded for a year to investigate a disease of rubber trees in the Federated Malay States which was then causing much concern to the planters. Returning home just before the first German War broke out, Brooks, as a keen patriot and former member of the Cambridge University Rifle Volunteers, endeavoured to enlist, but was not accepted on account of his eyesight. He did, however, render considerable assistance to the national effort by undertaking various technical investigations and when the Food Production Department was established he acted as plant pathologist to that institution. Among other matters this involved a study of the spread of potato blight, an extensive

investigation of the moulds developing on chilled meat delayed in transit from overseas, and some exciting work with an organism known as the 'XY bacillus' which fermented maize meal in the production of acetone then in great demand as a solvent in the manufacture of explosives.

Brooks resumed his University duties in 1919 in which year he was made lecturer. A great deal of extra teaching, apart from mycology and plant pathology, which was involved by the death of R. P. Gregory who lectured on algae and cytology now fell to Brooks who, in characteristic manner, tackled these new duties with earnestness.

For some years he carried out a long and important series of investigations into the silver leaf disease of fruit trees, collaborating in some of them with a few of his former students. The cereal rusts which he had commenced to study under Marshall Ward next received his attention and a lengthy research into the rusts of the brome grasses which was still in progress at the time of his death. A wide range of the fungous diseases of other cultivated plants was also undertaken during these years.

His great reputation as a plant pathologist had attracted a considerable number of research workers who came from all parts to work in his laboratory and to inaugurate new investigations under his stimulating influence.

In 1931 Brooks was elected a Fellow of the Royal Society and was also made a Fellow of his own College, Emmanuel; at about the same time a generous donation from the Rockefeller Foundation enabled the Botany School to expand so that Brooks was able to acquire a Field Station on part of the University Farm on which he planned and erected extensive glasshouses with laboratory facilities. In the same year he was made Reader in Mycology and five years later was elected to the Chair of Botany made vacant by the retirement of Sir Albert Seward. For the next twelve years the Botany School was extremely well administered, Brooks being one of those who loved efficiency and inspired willing co-operation. In 1947 he was made a C.B.E.

Though a little below the average height, Brooks was a keen participant of sport, playing tennis and squash racquets. He was a great walker and could outwalk many a bigger man; swimming he also enjoyed and up to the thirties always took an early morning plunge in the Cam throughout the year, running all the way there and back, a distance of nearly two miles, from his house in Tenison Avenue. At the back of this house was a large garden well stocked with uncommon flowers many of which he had collected and planted himself. He was ever fond of emphasizing the merits of good gardening and on one occasion expressed the opinion that one could not hope to be a botanist unless one was first and foremost a gardener. Brooks also indulged in dancing but was compelled to forego many energetic pursuits following a serious operation in 1940.

His many and varied activities were only made possible by the possession of an extremely orderly mind: he had a set time for most things though the routine was by no means inflexible. There were recognized times for laboratory work, correspondence and interviews in which he was ever ready to discuss difficulties with students or colleagues who profited much by his candid and sincere advice. His correspondence was enormous and increased rather than diminished as time went on, for he was very closely associated with several government institutions, being Chairman of a Committee of the Agricultural Research Council, a member of the Forestry Commission and of several governing bodies. In the midst of all he still carried on his research and completed writing the new edition of his book, *Plant Diseases* (now in press).

His lectures, both public and university, were most carefully prepared and the courses on mycology and plant pathology were so stimulating, that many on attending them soon decided to continue in these subjects and make them their lives' work. Thus, during the 40 years Brooks had charge of the teaching

of his chosen subject nearly one hundred trained mycologists and plant pathologists obtained posts in various parts of the world.

Possessed of great energy, transparent honesty and a will of iron, Brooks was greatly respected by all who came to know him and perhaps a little feared by the younger generation, for he did not suffer fools gladly and invariably expressed himself in no uncertain terms; but he was never resentful and was always fair. He had a great sense of humour, and many will miss, but always remember his loud and hearty laugh.

Brooks was elected a Fellow of the Linnean Society in 1922, serving on the Council from 1941-44, and as Vice-President 1943-44.

W. J. DOWSON.

Professor **Emile Topsent*** was born at Havre on 10 February 1862, and died at Dijon 22 September 1951. He began the study of natural sciences in the University of Caen, under Delage, who at that time had only two other students of natural history, P. A. Dangeard, the botanist and A. Bigot, the geologist. Even as a student he was a frequent visitor to marine laboratories and came under the influence of many other distinguished French zoologists and especially Lacaze-Duthiers.

He was appointed to the School of Medicine and Pharmacy at Rheims in 1889, in charge of the natural history department which included botany. From 1896 to 1904 he held a similar post at Rennes, after which he joined the staff of the Zoology Department at Caen University. In 1910 he was appointed Professor of Zoology and Physiology at the University of Dijon, and in 1915 also Director of the Natural History Museum at Dijon. On the opening of the French University in Strasbourg in 1919 he became their Professor of Zoology, and from 1921 to 1927 was Director of the Zoological Institute and Museum in Strasbourg. He was elected an Associate of the National Museum of Natural History in 1927 and after his retirement in 1932 was appointed honorary professor of the Faculty of Science in the Universities of both Dijon and Strasbourg.

In addition to his official duties Topsent took part in many other activities. Whilst at Caen he directed the Marine Laboratory at Luc-sur-Mer. He was also in charge of the Town Museum, and took an active interest in the Linnean Society of Normandy, his first publications (from 1885 to 1888) appearing in the journal of that Society. At Dijon his attempts to found a station for the study of fresh-water biology were successful, and the Station Grimaldi was opened at Saint-Jean-de-Losne in 1912 largely through grants obtained from Prince Albert I of Monaco.

Topsent was very fond of Dijon and returned there after his retirement from Strasbourg in 1932. He then occupied himself with the Zoological Museums both in the University and the Town.

Topsent was a voluminous writer and more than 190 publications appeared under his name including various large volumes of the Prince of Monaco's *Campagnes Scientifiques*.

His work dealt mainly with the classification of sponges but he also published articles on many other groups ranging from Protozoa to insects and even fossil vertebrates. He elucidated the life cycle of a species of *Adoxus*, a Chrysomelid beetle which reproduces parthenogenetically and was formerly a serious pest of vines. He also published an account of the interesting dipteron, *Ptychoptera albinana*.

Sponges, however, always remained his chief interest and he will be remembered mainly for his work on that group. His doctor's thesis and various

* The writer is indebted to Professor J. R. Denis, University of Dijon, for valuable assistance in obtaining the necessary information.

memoirs were devoted to the Clionidae. He worked out the sponge collections of *l'Hirondelle* and of the *Princesse Alice*, and numerous other collections from the Azores, Canary Islands, Senegal, Algeria, the Seychelles, Red Sea, Amboina, etc. and those of four Antarctic expeditions. He had an unrivalled knowledge of the French species and published chapters on the Tetractinellidae, Carnosa and Hadromerinae in *La Faune de France*. Unfortunately this monograph was not completed. He took great interest in the Mediterranean sponges and several times worked at the marine stations of Naples, Sete, Banyuls and especially Monaco. Apart from his outstanding taxonomic studies he threw light on many aspects of the morphology, histology and life histories of sponges.

Topsent was awarded various honours and decorations for his scientific contributions, including the Prix Cuvier in 1929 and the Prix Lasserre in 1933. He was elected a Foreign Member of the Linnean Society in 1932.

EDWARD HINDLE.

Stephen King Montgomery, who died at Cape Town on 20 January 1950, was a member of the South African Chapter of the American College of Chest Physicians and this obituary is based on that which appeared in *Diseases of the Chest*, No. 4, 17, 489, April 1950.

Born in Tasmania in 1895, he soon moved with his family to New Zealand, from whence, during his early boyhood, they returned to Perth in Western Australia, where he graduated B.A. with honours. After military service in the First Great War, he resumed his studies, taking B.Sc. with honours in Zoology. For his medical studies he proceeded to London, graduating M.B., B.S. in 1926. Resident posts at University College Hospital, the Hospitals for Tropical Diseases in London and Newcastle, and the British Hospital, Port Said, followed, and on his return to London he took his M.D. Choosing radiology as his special subject, he went to Edinburgh and obtained the Diploma in Radiology, with high distinction, in 1930. After a short spell of radiological practice in London, he settled in South Africa, first in Johannesburg and then in Cape Town. As a diagnostic radiologist he held a high place amongst his contemporaries and the University of Cape Town appointed him examiner for its Diploma in Radiology.

He was a frequent contributor to Medical Journals and an active member of the Medical Association of South Africa. During the Second Great War he organized and led a Radiological Unit; later he was Honorary Secretary of a large branch of the Ex-service Medical Officers' Society until failing health compelled him to relinquish practice in 1948. Dr. Montgomery had wide interests outside his professional work. He was elected a Fellow of the Linnean Society in 1925 and published several papers on crabs, the most important of which, a Report on the Brachyura of the Percy Sladen Trust Expedition to the Abrolhos Islands, appeared in the Society's Journal (Zoology) in 1931. For his leisure hours he had planned a study of the Diatoms of the False Bay Coast. He was fond of good music and a lover of poetry, deeply religious and very reserved and modest in his social contacts, yet withal a loyal friend and a fearless fighter against injustice in any form. He is survived by a widow, a son and a daughter.

John Gossweiler, who died in Lisbon on 19 February last, had been a Foreign Member of the Society since 1950, when he was elected in recognition of his signal services to African botany over a period of fifty years.

He was born on 24 December 1873, at Regensdorf, Zürich, where his father, Hans Gossweiler, owned a business. After preliminary studies in horticulture in Zürich, he continued his education at the Institute of Horticulture

in Stuttgart and afterwards in Dresden. These early years in Germany were not entirely happy ones and at about the age of twenty-three he came to London where he spent four years of scientific study, two at the Royal College of Science, South Kensington, and two at the Royal Botanic Gardens, Kew. At the latter institution he received an inspiration which coloured his whole life. Of Thiselton-Dyer, who was then Director of Kew, he always spoke with great respect, quoting him as a model of order and punctiliousness. During this period he learned to speak English with considerable fluency and used it for preference in his scientific works, though these took their final form in Portuguese. His field-notes, of which the originals were in English, especially during his earlier years, have an exuberance of style which give them a character all their own.

Towards the end of last century, the Government of Angola decided to establish a Garden of Acclimatization and Gossweiler was appointed for this work in 1899, when he left Europe for Luanda, where he made his home for more than half a century, though with numerous absences on his many excursions. Owing to administrative delays in starting the garden, he was able to devote much time during his first few years in Africa to beginning the collections that were to make his name famous in the great herbaria.

At that time our knowledge of the flora of Angola was mainly due to the work of Welwitsch during the middle of the 19th century, who collected principally in four regions: the coastal area of Luanda; the Cazengo forest and the adjoining strange and interesting region of Pungo Andongo; the desert of Mossamedes; and the Huilla Plateau. Apart from comparatively small collections made on Alexander von Mechow's Expedition and some specimens collected by Sisenando Marques, Pogge and Büttner in Malange and Lunda, the interior of the colony from Malange eastwards was botanically unexplored, while further south the region of Bié and the country to the east of the Chela Mountains were quite unknown.

Gossweiler's first specimens, which were sent to Europe in 1900, were from the littoral region of Luanda but he was soon able to follow in Welwitsch's footsteps in the Cazengo forest and Malange, where he re-collected many of the Welwitsch species and found a number of novelties. Meanwhile, in 1899-1900, Baum was exploring the Rivers Cunene and Cubango in the far south. Five years later, in 1905, Gossweiler was sent to the Ganguelas region (Bié) to study native rubber-producing plants and, with his base at the old Forte Princeza Amelia (now Vila da Ponte), on the River Cubango, he collected over an extensive and quite unknown region which linked up, in the south, with the area covered by Baum. In this Bié region there are large areas of 'chanas', small shrubs and low grass, burned every dry season by bush-fires and characterized by the peculiar species so often described by Gossweiler as 'polycephalous, rhizomatous undershrubs'. In these 'chanas' and in the 'tengas' or marshes along the river-valleys, he discovered a host of new species.

In 1907 work on the garden was at last begun. It was called the Cazengo Colonial Garden and the site chosen was the old, abandoned plantation known as the Granja de S. Luis. Here Gossweiler introduced many exotic species from tropical Asia and tropical America. During this period he made such a thorough exploration of the Cazengo rain-forest that it is now one of the best known areas, botanically, in tropical Africa.

It is impossible to recount in detail all Gossweiler's numerous collecting trips in Angola and I must confine myself to those which gave the most important botanical results. Beyond doubt the most fruitful of all were his three or four visits to the great Mayumbe rain-forest in the Cabinda Enclave. Almost all that we know of this forest, as regards the part of it which lies in Portuguese territory, is due to Gossweiler's efforts. At various times he

visited Subluali, Pango Munga, Caio and Belize, and camped with his wife, for many months, in an isolated region near the source of the River Zanza. The resulting collections were rich in new species.

From 1919–1926 he left the government service and worked privately for Fomento Geral de Angola. During these years he collected along the southern bank of the Congo, at Quissama, in the Dembos region and along the River Bengo.

He re-entered the service of the Angolan Government in 1927 and was charged with the organization of an Experimental Cotton Station at Catete.

In 1932 he was sent to investigate diseases of coffee in Amboim and had his first opportunity thoroughly to explore the mist-forest in the neighbourhood of Gabela and Capir (Cuanza Sul). The collections he made established the fact of a great southerly extension of the rain-forest flora, which here reaches its southern limit in West Africa.

In 1938 he accompanied the late Professor Carrisso's Botanical Mission and his vast experience of the country greatly contributed to the success of this expedition, marred though it was by the death of its leader in the Mossamedes desert. Gossweiler, accompanied by my wife and myself, organized the return journey from Sá de Bandeira by road to Luanda with the Mission's large collections and he afterwards went with us on further collecting trips to Cazengo and Amboim.

His last important collection was made in 1947, when he was seventy-four years old, in the gallery-forests at Dundo, in the extreme north-east of the colony, on the frontier of the Belgian Congo. This added many new species to the Angolan flora and showed interesting links with the flora of the Mayumbe forest in Cabinda.

Owing to its long connection with Angola, dating from the time of Welwitsch, it was natural that the Botany Department of the British Museum should take a special interest in the Gossweiler collections and for many years several members of its staff were regularly engaged in publishing the identifications and descriptions of his plants in the *Journal of Botany*. He sent the first set of most of his collections to the British Museum and the Portuguese generously allowed him to distribute his duplicates to many European and American herbaria. His name is commemorated by the genera *Gossweilera* (Compositae) and *Gossweilerodendron* (Leguminosae) as well as by numerous specific epithets.

Although it is to his collections, amounting in all to over 14,000 numbers, that Gossweiler will owe an enduring fame, he was also the author of a number of papers on Angolan plants of economic importance and of two major works, the *Carta Fitogeográfica de Angola* (1939), written in collaboration with F. A. Mendonça, and the *Flora Exótica de Angola* (1949–50). The *Carta Fitogeográfica* contains the fruits of his observations made during his many journeys throughout the length and breadth of Angola and is, in spite of some details which may need correction, a work of great value to the phytogeographer and ecologist.

John Gossweiler was small, thin and wiry, and must have had an excellent constitution; for fifty years' collecting in tropical Africa is probably a record unequalled by any other botanical collector in such a climate. He was full of energy and untiring in the field in his search for new and interesting plants. He had been so long isolated from the main centres of botanical study that his ideas seemed sometimes a little strange, and as he held to them with great obstinacy and determination, fierce arguments with his Portuguese companions often developed.

My wife and I, who travelled for thousands of miles with him, owed much to his courage and kindness in times of difficulty and adversity and felt for him the affection and respect due to a kindly man of great integrity of character.

John Gossweiler and his charming Swiss wife, Marthe Gossweiler, who survives him, were much loved in Luanda, where he will be greatly missed. They have one daughter, Ruth, who is married in Switzerland.

He has left us not only affectionate memories but also a great task. There is still a lifetime's work to be done in classifying the material he collected.

John Gossweiler was a Fellow of the Society from 1905-1937.

A. W. EXELL.

John McConnell Black author of *The Flora of South Australia*, died at his home in Adelaide on 2 December 1951, in his ninety-seventh year. At the time of his death he was engaged in the revision of his *Flora*. The Second Edition of Part I had appeared in 1943 and of Part II in 1948; it had been decided that Part III of the revision should end with Plumbaginaceae and not as previously with the Scrophulariaceae. Black had practically completed the text of this family on the evening before his death and had left open on his table the botanical works that he had then been consulting. Part III will have been published by the Government Printer, Adelaide, before this notice appears. Black's additions, notes and corrections for Part IV are so complete that the Handbooks Committee of the South Australian Branch of the British Science Guild has arranged for the final part to be prepared for the press forthwith. In spite of his great age, his mind had remained alert and critical up to the last.

J. M. Black was born at Wigtown in Scotland on 28 April 1855, the son of George C. Black, Procurator-Fiscal. He was educated at the Grammar School in his native town, at the Edinburgh Academy, at Taunton College School and finally at the Dresdener Handels-Schule in Germany. He spent a short while with the British Linen Company's Bank in Edinburgh and then with the Oriental Bank in London. In 1877 he came to South Australia, and after an experience of five years of farming in a rather dry portion of that State, turned to journalism and also became a Hansard reporter. For the rest of his life his home was in Adelaide. In 1902 a legacy from his sister enabled him to retire at the age of 47, and to devote himself to the studies that particularly appealed to him. In South Australia he found to his hand an open field for the study of its plants and, being an accomplished linguist, the opportunity to record aboriginal languages. His first publication as an amateur botanist was *The Naturalised Flora of South Australia* which appeared in 1909 and was well illustrated with his own drawings. In the same year he contributed to the *Transactions of the Royal Society of South Australia* (Volume 33) the first of a series of papers, later entitled 'Additions to the Flora of South Australia', which ended with No. 45 in 1949 (Volume 73). These *Transactions* were the vehicle for his more important contributions, botanical and linguistic. They contain several other papers of his besides the 'Additions', some dealing with the botanical results of scientific expeditions into the interior of the continent.

In 1920 the South Australian Branch of the British Science Guild—the Guild itself is now merged in the British Association for the Advancement of Science—approached the Premier of the day, Sir Henry Barwell, with a proposal for a series of handbooks on the fauna and flora of the state. These were to be prepared by specialists working in an honorary capacity and presented as a gift to the State if the Government were prepared to publish them. The Premier described this as 'a very generous offer', it was approved by Cabinet, and J. M. Black was asked if he would undertake the preparation of the first Handbook, *A Flora of South Australia*. Part I of this *Flora* appeared in 1922, the first of a long series of works dealing with the plants and animals of that State. Part IV was completed in 1929.

In South Australia many new plants awaited recognition though Black's predecessors, Robert Brown, Baron Ferdinand von Mueller, Professor Ralph Tate and Dr. R. S. Rogers, aided by the ardent collector J. G. O. Tepper and the collections made on expeditions of exploration, had recorded or described a majority of the native plants. Moreover, alien plants were establishing themselves in ever-increasing numbers and replacing to a great extent the indigenous ones in settled areas. Not only did distant parts of the dry interior—the sandhills of Ooldea on the East-West Line, the mulga and the saltbush plains, the rugged mountains of the Far North-West, the *Triodia*-covered hills and the sandy beds of watercourses—yield new species of vascular plants but several were discovered by his collectors in the Encounter Bay district, and one, a very distinct species of *Lomandra* (*L. densiflora*—Liliaceae), on the foothills near Adelaide and even within the bounds of that capital city. This *Lomandra* had escaped recognition as its flowers were hidden at the base of stiff grasslike leaves and appeared unduly early in spring. Black described seven genera as new—*Pectinella*, 1913, later sunk in *Cymodocea* (Potamogetonaceae); *Griffithia*, 1913, later included in *Helipterum* (Compositae); *Uldinia*, 1922 (Umbelliferae); *Hymenocapsa*, 1925, now sunk in *Gilesia*, or *Hermannia* (Sterculiaceae); *Embadium*, 1932 (Boraginaceae); *Clelandia*, 1932 (Violaceae); and *Sarcozona*, 1934 (Aizoaceae). He also described approximately 178 new species and 40 new varieties and effected a number of new combinations. Amongst his more interesting or important species are *Uldinia mercurialis* and the tall handsome *Nicotiana excelsior* used by the natives from time immemorial for chewing. His herbarium was bequeathed to the University of Adelaide.

Black was remarkably thorough in all his work. He could never rest till a problem had been solved. When new specimens were received notes and excellent drawings were appended to the herbarium sheet. At the same time he made marginal notes in the working copy of his *Flora*, adding to or modifying descriptions previously made as might be necessary. Thus, when the time for revision came, much of the work was already done, ready for review. With meticulous care the manuscript was then prepared for the printer. Nearly all his work was done at his home.

In 1930, Black attended the Fifth International Botanical Congress in Cambridge. It was then that he became an Associate of the Linnean Society *honoris causa*. He was appointed as Honorary Lecturer in Systematic Botany in the University of Adelaide from 1927.

He was awarded the Vercò Medal of the Royal Society of South Australia in 1930, the Mueller Memorial Medal of the Australian and New Zealand Association for the Advancement of Science in 1932, the Australian Natural History Medallion (Field Naturalists' Club of Victoria) in 1944, and the Clarke Memorial Medal of the Royal Society of New South Wales in 1946. He received the honour of M.B.E. in 1942.

Among the latest new species to be described by J. M. Black is *Bulbostylis eustachii*, a sedge from the Evarard and Musgrave Ranges. This was collected by his second son, Dr. Eustace C. Black, in April 1930 and named after him. The description has not yet been published but will appear in the 'Additions' incorporated in Part III of the *Flora*. His daughter predeceased him but two other sons survive with grandsons and great-grandchildren.

J. B. CLELAND.

It was almost by accident that **William Williamson**, joint author with C. D. Soar of the Ray Society's monograph on British water-mites, took up the study at which he became an acknowledged expert. He was born in Leith in 1869, had no scientific training, and spent practically all his working life in the employment of the Scottish American Mortgage Company of

Edinburgh, in which he rose to be chief clerk, with very considerable responsibilities in the handling of the real estate business of the Company.

He showed no special bent in his early years for the study of natural history, but he was an omnivorous reader, and in the miscellany from which he stored his mind, he encountered, at the age of thirty, the articles on British water-mites which C. D. Soar was then contributing to *Science Gossip*. Williamson set about collecting these microscopic inhabitants of ponds, found that he could readily identify them with the aid of Soar's detailed descriptions, and soon got into touch with Soar himself. This was the beginning of a friendship which lasted until Soar's death almost forty years later, and it provided a stimulus which turned the hesitating amateur into a skilled collector and accomplished microscopist.

He described his own collections of water-mites from several Scottish localities, named the collections made during Murray and Pullar's *Survey of Scottish Fresh-water Lochs*, revised the early lists of Johnston from Berwickshire and Dalyell's *Scottish Hydrachnids*, and described several new or rare species. Then the two amateurs, Soar and Williamson, arranged to collaborate in the production of a work which is a lasting monument to both—the Ray Society's three-volume monograph on *The British Hydracarina*. The volumes appeared in 1925, 1927 and 1928, Soar being entirely responsible for the beautiful figures and Williamson taking main responsibility for the synonymy and descriptive text.

Williamson was a Fellow of the Royal Society of Edinburgh and of the Royal Microscopical Society as well as of the Linnæan Society (elected in 1916) and for many years he was active as an office-bearer of the Royal Physical Society of Edinburgh. His latter years were clouded by ill-health, but he remained full of interest in his books and in his water-mites until his last illness. He died in Edinburgh on 19 December 1950, his wife having predeceased him by a few months.

JAMES RITCHIE.

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Note.—Names of donors are given in square brackets. Separate copies of papers which are included in periodicals received by the Library are no longer catalogued.

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- The Hydrangeas. Pp. viii+185. 8vo. *London*, 1950. [AUTHOR.]

- Henderson, M. R.** Malayan wild flowers. Parts 1 & 2. 8vo. *Kuala Lumpur*, 1949-50.
- Henrard, J. Th.** Monograph of the genus *Digitaria*. Pp. xxi+999. 8vo. *Leiden*, 1950.
- Herklots, G. A. C.** The Hong Kong Countryside. Pp. 175. 8vo. *Hong Kong*, 1951. [AUTHOR.]
- Hörstadius, Sven.** The neural crest. Pp. x+112. 8vo. *London*, 1950.
- Howden, Robert.** See **Gray, Henry.**
- Hutchinson, John.** British flowering plants. Pp. viii+374. 8vo. *London*, 1948.
- . More common wild flowers. Pp. xxx+234. 8vo. *West Drayton*, 1948.
- . Uncommon wild flowers. Pp. 254. 8vo. *Harmondsworth*, 1950. [AUTHOR.]
- Hyamson, Albert M.** A dictionary of universal biography. Pp. xii+680. 8vo. *London*, 1951.
- Inglis, Bessie D.** Wild flower studies. Pp. x+150. 8vo. *London*, 1951. [PUBLISHERS.]
- Inglis-Jones, Elisabeth.** Peacocks in Paradise. Pp. 255. 8vo. *London*, 1951. [AUTHOR.]
- Jeannel, René.** Hautes montagnes d'Afrique. Pp. 254. 8vo. *Paris*, 1950.
- Jepson, G. L., & others.** Genetics, Paleontology and Evolution. Pp. xiv+474. 8vo. *Princeton*, 1949.
- Jespersion, Paul & Tåning, Å. Vedel.** Edited by. Studies in Bird Migration, being the collected papers of H. CHR. C. MORTENSEN 1856-1921. Pp. 272. 8vo. *Copenhagen*, 1950.
- Johansen, Donald Alexander.** Plant Embryology. Pp. xviii+305. 8vo. *Waltham, Mass.*, 1950.
- Johnson, C. Pierpoint.** The useful plants of Great Britain. Pp. vi+324. 8vo. *London*, 1862. [FULHAM PUBLIC LIBRARIES.]
- Kerr, John Graham.** A Naturalist in the Gran Chaco. Pp. xiv+230. 8vo. *Cambridge*, 1950.
- Lousley, J. E.** Wild flowers of Chalk and Limestone. (New Naturalist Series.) Pp. xviii+254. 8vo. *London*, 1950.
- Macan, T. T., & Worthington, E. B.** Life in lakes and rivers. Pp. xvi+272. (New Naturalist Series.) 8vo. *London*, 1951.
- Maheshwari, P.** An introduction to the embryology of Angiosperms. Pp. x+451. 8vo. *New York*, 1950.
- Manton, I.** Problems of Cytology and Evolution in the Pteridophyta. Pp. xii+316. 8vo. *Cambridge*, 1950.
- Moog, Florence.** Structure and development of the Vertebrates. Pp. xii+170. *New York*, 1949.
- Mooney, Herbert.** Supplement to the Botany of Bihar & Orissa. Pp. vi+294. 8vo. *Ranchi*, 1950. [AUTHOR.]
- Mortensen, H. Chr. C.** See **Jespersion, Paul & Tåning, Å. Vedel.**
- Nicholson, E. M.** Birds and Men. Pp. xvi+256. 8vo. *London*, 1951.
- Praeger, R. L.** Natural history of Ireland. Pp. 350. 8vo. *London*, 1950.
- Prestwich, Arthur A.** Records of Parrots bred in captivity. Parts 1-4. 8vo. *London*, 1950-1.
- . Records of Birds of Prey bred in captivity. Pp. 26. 8vo. *London*, 1950. [AUTHOR.]
- Reed, F. J.** Lawns and playing fields. Pp. 212. 8vo. *London*, 1950. [AUTHOR.]
- Reynolds, G. W.** The Aloes of South Africa. Pp. xxiv+520. 8vo. *Johannesburg*, 1950.
- Robbins, W. W., & Weier, T. E.** Botany. An introduction to plant science. Pp. 480. 8vo. *London*, 1950. [PUBLISHERS.]
- Sampson, K.** See **Ainsworth, G. C.**
- Schmid, Emile.** Carte de la végétation de la Suisse. Feuille No. 1-No. 4. *Berne*, 1947-50.
- Simpson, George Gaylord.** The meaning of Evolution. Pp. xvi+364. 8vo. *Oxford*, 1950.
- Sower, F. A.** Introduction and history of Lichenology in the Counties of Leicestershire and Rutland. Pp. 74. 8vo. *Leicester*, 1950. [AUTHOR.]
- Stebbins, G. L.** Variation and Evolution in Plants. Pp. xx+644. 8vo. *Oxford*, 1950.
- Smith, Malcolm.** The British Amphibians and Reptiles. Pp. xiv+318. (New Naturalist Series.) 8vo. *London*, 1951.
- Summerhayes, V. S.** Wild Orchids of Britain. Pp. xvii+366. (New Naturalist Series.) 8vo. *London*, 1951.
- Tåning, Å. Vedel.** See **Jespersion, Paul.**
- Thompson, Harold.** Pelagic Tunicates of Australia. Pp. 196. 8vo. *Melbourne*, 1948.
- Wakefield, Elsie M., & Dennis, R. W. G.** Common British Fungi. Pp. 290. 8vo. *London*, 1950.
- Wallis, T. E.** Textbook of Pharmacognosy. Pp. xii+556. Ed. 2. 8vo. *London*, 1951. [AUTHOR.]
- Worthington, E. B.** See **Macan, T. T.**
- Young, J. Z.** The life of Vertebrates. Pp. xvi+767. 8vo. *Oxford*, 1950.

BENEFACTIONS

LIST *in accordance with Bye-Laws, Chap. 17, Sect. 1, of all Donations of the amount or value of Twenty pounds and upwards, received during the past five years.*

1947

- The Royal Society : Grant-in-aid of publications, £750.
 Anonymous Donor : Towards the reorganization of the Library, £100 ; and two mahogany bookshelves.
 Mr. Reginald L. Hine, F.S.A. : Manuscript botanical note-book written by Thomas Lawson in 1676-77.

1948

- The Royal Society : Grant-in-aid of publications, £750.
 Dr. J. Jaramillo-Arango : Donation towards cost of plates for his paper in *Journal, Botany*, £45.
 The Pilgrim Trust : Grant to form the nucleus of the Library Restoration Fund, £2500.
 Royal Academy, Inverness : Copy of Thornton's *A new illustration of the Sexual System of Linnaeus*.
 Imperial Chemical Industries : Donation to the Library Restoration Fund, £50.
 Royal Horticultural Society : Donation to the Library Restoration Fund, £105.
 Zoological Society of London : Donation to the Library Restoration Fund, £25.
 Dr. G. H. Pethybridge : Bequest for general purposes, £100.

1949

- The Royal Society : Grant-in-aid of publications, £750 ; Grant-in-aid of the Library, £250.
 Mrs. C. M. Snow, F.L.S. : Donation to the Library Restoration Fund, £30.
 Colonel F. C. Stern, O.B.E., M.C. : Donation to the Library Restoration Fund, £45.
 Mr. A. E. Günther : 42 volumes of the late Dr. Albert Günther's work books, with a book-case.
 Imperial Botanical Conference Trustees : Donation to the Library Restoration Fund, £57 4s. 11d.
 Anonymous donor : £25 to the Library Restoration Fund.
 The late Mr. R. J. Flintoff, F.L.S. : £1000 free of Legacy Duty.
 Research Committee of the University of Liverpool : Donation towards the cost of Dr. C. Leighton Hare's paper on *Eriocaulon*, £25.
 Miss I. M. Hayward : Bequest of £100 for general purposes.
 Mr. D. J. Scourfield, I.S.O. : Bequest of £100 for general purposes.

1950

- The Royal Society : Grant-in-aid of publications, £750.
 Miss E. F. Noel : Bequest of £100 for general purposes.
 Mr. E. A. Robins : Long run of the Society's publications.
 Mr. W. C. Barton : Long run of the Society's publications.
 Mrs. E. W. Sexton : Donation towards the cost of the joint paper on *Jassa* in the *Journal, Zoology*, £50.

1951

- The Royal Society : Grant-in-aid of publications, £750.
 Mr. James Insch, F.L.S. : Bequest of Library of works on Tea.

THE SYSTEMATICS ASSOCIATION

ANNUAL REPORT X (1950-51)

The Ninth Annual Report for the year 1949-50 was adopted at the Annual General Meeting held on 5 May 1950 in the Herbarium, Royal Botanic Gardens, Kew, at the invitation of the Director. The formal meeting was preceded by a demonstration on the methods of botanical taxonomy which was well attended.

A discussion on "Phylogeny in relation to classification" was held in the rooms of the Linnean Society on 14 December 1950 at 5.0 p.m. This was opened by Prof. A. A. Boyden, Rutgers University, New Brunswick, life-member of the Association, and by Dr. E. J. H. Corner, Botany School, Cambridge. This was followed by a lively discussion. An account of the meeting has been published in *Nature*, **167**, 31 March 1951, 503-505.

A joint discussion with the Linnean Society on the "taxonomic treatment of biological races" was held in the rooms of the Linnean Society on 22 February 1951 at 5.0 p.m. The principal speakers were Mr. B. L. Burtt (flowering plants), Dr. C. A. Hoare, F.R.S. (parasitic Protozoa), Dr. R. W. G. Dennis (Mycology), and Mr. P. F. Mattingly (the *Culex pipiens* complex). A full report of this discussion will be published by the Linnean Society.

Following a suggestion made at the demonstration of Botanical Taxonomy at Kew last year, a "Northern Committee of the Systematics Association" has been set up. This Committee has organized a discussion on "Evolutionary trends and classification" held in Leeds City Museum on Saturday, 28 April 1951. The following papers were included: "Units of evolution and units of classification" by Dr. J. M. Thoday (Sheffield); "Evolutionary trends and classification in the Bryophyta" by Professor P. W. Richards (Bangor); "Trends in the degree of diversification of Diatoms" by Professor J. Small (Belfast); "Is phylogenetic speculation necessary to the practising taxonomist?" by Dr. O. W. Richards (Slough); "The evolution and phylogeny of the insects with special reference to classification of the Homoptera-Psyllidae" by Dr. G. Heslop Harrison (Newcastle); "Some problems in invertebrate palaeontology" by Dr. R. M. C. Eagar (Manchester); "Taxonomy and evolution in very polymorphic species" by Dr. A. J. Cain (Oxford).

Activities of Committees.(a) *Research.*

Mr. B. L. Burtt has received and dealt with a number of inquiries with regard to subjects suitable for research.

(b) *Maps and Censuses.*

There is little further progress to report. The vice-counties maps are not yet ready for publication. Blocks of experimental maps of tropical Africa have been made on the basis of work done at Kew Gardens.

(c) *Education.*

No meeting has been held during the year.

(d) *Taxonomic Principles.*

Mr. Alston organized a very successful discussion in committee of the late Mr. Wilmott's paper on "Infra-specific categories": one result of this discussion was the Joint Meeting with the Linnean Society on Biological Races reported above. Preliminary steps have been taken towards the production of a successor to the *New Systematics*.

(e) *Handbooks*.

Key Works is ready for the press. The botanical section has been completely rewritten and a small addition on Pollen Analysis is now included.

The second set of lectures by the Linnean Society in conjunction with the Systematics Association 1949-1950 "On the Practice of Botanical and Zoological Classification" has now been published by the Linnean Society, 1951. Price 4/-.

J. P. HARDING,
R. MELVILLE.

Hon. Secretaries.

THE SYSTEMATICS ASSOCIATION

ANNUAL REPORT XI (1951-52)

The Tenth Annual General Meeting was held on 4 May 1951 at the Herbarium, Royal Botanic Gardens, Kew, by kind permission of the Keeper, Dr. W. B. Turrill. The Tenth Annual Report was adopted and is being published in the *Proceedings of the Linnean Society*.

By invitation of the Director, Sir Edward Salisbury, at the conclusion of the business meeting, members inspected and discussed a series of exhibits in the Herbarium illustrating various problems and techniques in botanical taxonomy.

A well attended Joint Meeting of the Association with the Linnean Society took the form of a discussion on "Growth and Systematics", held in the Rooms of the Linnean Society on Thursday, 20 March 1952. The discussion was opened by Professor W. E. Le Gros Clark with a paper on "Growth in relation to the Systematics of the Primates", followed by Dr. R. M. C. Eagar who spoke on "Relative growth in Shells of the Fossil Family Anthracossidae during the Carboniferous Period", and Dr. R. Melville on "Growth in relation to Plant Systematics". A general discussion followed. A full account of the meeting will be published in the *Proceedings of the Linnean Society*.

The Northern Committee of the Association, convened by Dr. H. G. Baker, organized a meeting to discuss the "Taxonomic Treatment of Ecological Races". At the invitation of Professor D. H. Valentine, this was held on 9 February 1952 at 2.30 p.m. in the Department of Botany, University of Durham, and was attended by a number of members and visitors from Northern, Scottish and Belfast Universities. The good attendance and the animated discussion that ensued provided further justification for provision of provincial meetings. A very full account of the meeting held at Leeds in 1951 was published in the *Proceedings of the Leeds Literary and Philosophical Society* and reprints will be distributed to members as soon as available. Reprints of the discussion on "Phylogeny in Relation to Classification", *Nature*, **167**, 503, and "A Joint Discussion with the Systematics Association on Biometrics and Systematics", *Proc. Linn. Soc.* **162**, 1949-50, 153-178, have been distributed.

The reorganization of the work of committees has been discussed by Council as it was felt that some of them had fulfilled their purpose and should be disbanded. In the light of changing conditions, it was decided that the purposes of the Association might often be better served by the appointment of temporary panels to undertake specific tasks rather than by permanent committees. The existing committees have been dealt with as follows:

(a) *Research*. Only the botanical section of this committee has been active. Mr. B. L. Burt at Edinburgh has been asked to continue to maintain the card index relating to taxonomic research on the British flora in collaboration with

Mr. R. D. Meikle at Kew, a copy to be kept at both centres. The Zoological Secretary agreed to direct enquiries concerning zoological research to appropriate persons.

(b) *Maps and Censuses.* The work of this committee was not yet completed as it had to arrange for the publication of the Vice-Counties maps. Mr. Dandy had nearly finished his work and it was hoped that publication could be undertaken by the end of the year.

(c) *Education.* As a result of altered conditions, it does not seem desirable to proceed further with the textbooks that were to have been sponsored by this committee, except for the more advanced book on botanical taxonomy. It was decided that the present committee should be discontinued and a panel consisting of Dr. W. B. Turrill, Mr. S. M. Walters and Mr. J. E. Dandy should be formed to consider the best methods of dealing with this project and to report back to Council.

(d) *Taxonomic Principles.* This committee has a large body of data on infra specific categories which was collected while the late A. J. Wilmott was convener. During the year Mr. P. C. Sylvester-Bradley has undertaken the convenership in place of Mr. Alston, who was in indifferent health. The data have been collated, and a meeting was held on 11 March 1952 in the Board Room of the British Museum (Natural History) to discuss the classification and coordination of infra specific categories with a view to subsequent publication. A glossary and preliminary attempt at classification had been drawn up by the convener, and circulated to members before the meeting. Fourteen members were present, and written contributions were sent by a number of others. Both botanists and zoologists were well represented. Dr. Turrill was elected to the chair. A substantial measure of agreement was reached as to the principles which should be adopted as the basis of such a classification. Mr. Gilmour was asked to prepare a schedule of categories for discussion at a future meeting. It has been agreed that the glossary and preliminary classification of infra specific categories shall be circulated to all members of the Association with an invitation to take part in any future discussions on the subject if they so desire.

(e) *Handbooks.* It was agreed that this committee has fulfilled its purpose and should be dissolved. In the future, publications will be handled by panels appointed for the purpose as required.

There were 191 members of the Association on 30 April 1952, of whom 36 were life or founder members.

J. P. HARDING,
R. MELVILLE,
Hon. Secretaries.

THE SYSTEMATICS ASSOCIATION: ACCOUNTS FOR THE YEAR 1950-51

ORDINARY ACCOUNT.		EXPENDITURE	
INCOME		(Balance taken on 1 May 1951)	
	£ s. d.		£ s. d.
Balance at the Westminster Bank on 1 May 1950.....	178 16 11	<i>Outstanding from 1950 :-</i>	
Subscriptions	33 10 3	Secretarial expenses	4 12 0
Sale of <i>Key Works</i> (2 copies)	12 6	Treasurer's expenses	11 0
Royalties of the <i>New Systematics</i> (for year ending		Secretarial expenses (1951)	7 4 4
31 March 1950)	60 3 3	Transferred to Special Fund	5 0 0
Received in respect of report on a meeting of the Association		Director General of Ordnance Survey (maps required for	
published in <i>Nature</i>	1 18 0	Mr. Dandy's work for the Association)	3 4 8
		Linnean Society (reprints)	12 7 9
		<i>Nature</i> (reprints)	1 15 0
		Balance at the Westminster Bank on 1 May 1951	240 6 2
	<u>£275 0 11</u>		<u>£275 0 11</u>

Outstanding :-

Treasurer's expenses	£ s. d.
Subscription for Affiliation with Leeds Philosophical and	1 1 3
Literary Society	1 1 0
Mr. P. C. Sylvester Bradley (expenses in connexion with	
organization of Leeds meeting)	2 13 2
	<u>£4 15 5</u>

SPECIAL ACCOUNT.

INCOME		EXPENDITURE	
	£ s. d.		£ s. d.
Balance in Post Office Savings Account on 1 May 1950	340 18 11		
Life Membership Subscriptions (5)	25 0 0		
Transferred from Ordinary Account	5 0 0		
Donations	5 0		
Interest	8 11 6		
	<u>£379 15 5</u>	Balance in Post Office Savings Bank on 1 May 1951	£379 15 5

E. B. BRITTON, *Hon. Treasurer.*

Audited and found correct :-

V. S. SUMMERHAYES, } *Hon. Auditors.*
B. L. BURTT,

3 May 1951.

THE SYSTEMATICS ASSOCIATION : ACCOUNTS FOR THE YEAR 1951-52

1951-52

GENERAL ACCOUNT.

INCOME

	£	s.	d.
Balance at Westminster Bank on 1 May 1951.....	240	6	2
Clarendon Press : royalties on <i>The New Systematics</i>	22	9	5
Annual subscriptions	31	0	0

EXPENDITURE

	£	s.	d.
<i>Outstanding from 1951 (as per last account) :—</i>			
Britton : Honorary Treasurer's expenses.....	1	1	3
Leeds Literary and Philosophical Society.....	1	1	0
Sylvester-Bradley : organization of Leeds meeting.....	2	13	2
Cheque book.....	10	0	
Harding : Honorary Zoological Secretary's expenses.....	4	7	6
Couldrey & Co. : duplicating paper	5	18	6
Leeds Literary and Philosophical Society.....	1	1	0
Baker : Northern Discussion Group, Durham.....	1	3	6
Sylvester-Bradley : Taxonomic Principles Committee	4	12	11
Publications distributed to members.....	—	—	—
Balance at Westminster Bank on 30 April 1952	271	6	9

£293 15 7

THE SYSTEMATICS ASSOCIATION

1951-52

SPECIAL ACCOUNT.

	£	s.	d.
Balance in Post Office Savings Bank account on 1 May 1951.	379	15	5
Life membership (1)	5	0	0
Interest 1951	9	10	1

£394 5 6

	£	s.	d.
Sundry expenditure.....	—	—	—
Balance in Post Office Savings Bank account on 30 April 1952	394	5	6

£394 5 6

BALANCE SHEET.

	£	s.	d.
Founder and Life Members (36)	180	0	0
Annual subscriptions in advance (84)	21	0	0
Sundry creditors :—			
Honorary Treasurer.....	2	3	1
Honorary Zoological Secretary	10	19	0
Honorary Botanical Secretary (est.)		5	0
Excess assets over liabilities	460	11	2

£674 18 3

	£	s.	d.
Balance in Post Office Savings Bank.....	394	5	6
Balance at Westminster Bank	271	6	9
Subscriptions—1 year in arrear (39 at 4/-)	7	16	0
Subscriptions—2 years in arrear (15 at 2/-)	1	10	0
Stocks of books.....	—	—	—

£674 18 3

G. J. KERRICH, *Hon. Treasurer.*

Audited and found correct :—

V. S. SUMMERHAYES, } *Hon. Auditors.*
E. MILNE-REDHEAD, }

5 May 1952.

THE LINNEAN SOCIETY OF LONDON,

BURLINGTON HOUSE, PICCADILLY, LONDON, W. 1.

SOME SPECIAL PUBLICATIONS.

A Catalogue of the Linnaean Herbarium, compiled and annotated by Spencer Savage, F.L.S. London, 1945. (Pp. xvi+226, frontisp., 8 plates and pull-out leaf.) £3 net.

Synopses of the British Fauna :—

No. 1. *Opiliones (Arachnida) or Harvestmen*. By Theodore H. Savory, M.A., F.Z.S. (New Edition.) 2s. net.

No. 2. *Caprellidea (Amphipoda, Crustacea)*. By R. J. Harrison, B.A., A.L.S., 1s. 4d. net.

No. 3. *Gammaridae (Amphipoda)*; with *Key to the Families of British Gammaridea*. By D. M. Reid, F.L.S. 3s. 4d. net.

No. 4. *Freshwater Bivalves (Mollusca)*,—(*Corbicula, Sphaerium, Dreissena*). By A. E. Ellis, M.A., F.L.S. 2s. 6d. net.

No. 5. *Freshwater Bivalves (Mollusca)*,—(*Unionacea*). By A. E. Ellis, M.A., F.L.S. 5s. od. net.

No. 6. *Lumbricidae (Annelida)*, with a *Key to the common Species*. By Dr. L. Cernovitov† and Dr. A. C. Evans. 2s. 6d. net.

No. 7. *Talitridae (Crustacea, Amphipoda)*. By D. M. Reid, F.L.S. 2s. 6d. net.

No. 8. *Slugs (Mollusca)*,—(*Testacellidae, Arionidae, Limacidae*). By H. E. Quick, M.B., B.Sc., F.R.C.P. 2s. 6d. net.

Catalogue of the Printed Books and Pamphlets in the Library of the Linnean Society of London. New Edition, London, 1925. (Pp. 860.) 13s. 4d. net.

General Index to the first Twenty Volumes of the Journal (Zoology) . . . London, 1896. (Pp. 437.) 6s. 8d. net.

General Index to the first Twenty Volumes of the Journal (Botany) . . . London, 1888. (Pp. 428.) 6s. 8d. net.

The Darwin-Wallace Celebration held on Thursday, 1st July, 1908, by The Linnean Society of London. London, 1908. (Pp. 118.) 3s. 4d. net.

Catalogue of the Manuscripts in the Library of The Linnean Society of London.—Part 1. *The Smith Papers. (The Correspondence and Miscellaneous Papers of Sir James Edward Smith, M.D., F.R.S., first President of the Society.)* By Warren R. Dawson, F.R.S.E., London, 1934. (Pp. 114.) 13s. 4d. net.

[Continued overleaf.]

SPECIAL PUBLICATIONS (*continued*).

Catalogue of the Manuscripts in the Library of The Linnean Society of London.—Part 2. *Caroli Linnaei Determinationes in hortum siccum Joachimi Burseri.*—The text of the manuscript in the Linnaean Collections, edited by Spencer Savage, F.L.S. London, 1937. (Pp. 78.) 13s. 4d. net.

—Part 3. *Synopsis of the Annotations by Linnaeus and contemporaries in his Library of Printed Books.* By Spencer Savage, F.L.S. London, 1940. (Pp. 20.) 6s. 8d. net.

—Part 4. *Calendar of the Ellis Manuscripts.* (*The Correspondence and Miscellaneous Papers of John Ellis, F.R.S.*) By Spencer Savage, F.L.S., Hon. Memb. Sv. Linné-sällsk. (Pp. vi, 104.) London, 1948. 25s. net.

Lectures on Taxonomy (1948-49), *Lectures on the Development of Taxonomy, and* (1949-50), *Lectures on the Practice of Botanical and Zoological Classification.* 4s. od. each.

A History of The Linnean Society of London. By A. T. Gage, C.I.E., LL.D., F.L.S. (Pp. viii, 175, Pl. 11.) 6s. 4d. net.

‘A *Prodromus* of the British *Hieracia*.’ By the late H. W. Pugsley, B.A., F.L.S., has been published as Vol. 54 of the Society’s *Journal, Botany*, comprising pp. iv, 356, and 17 plates. Copies are available for purchase by non-members, £3.